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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

APRIL, 1920

Vol. XI, No. 4

NATIVE HORSES AND CATTLE IN THE ORIENT

A GRAPEFRUIT VARIETY HAVING PINK COLORED FRUITS

HERITABLE CHARACTERS OF MAIZE

FOREIGN PLANT INTRODUCTION MEDAL

COTTON A COMMUNITY CROP

ARE OUR RASPBERRIES FROM AMERICAN OR EUROPEAN SPECIES

ILLUSTRATING STRUCTURE OF HUMAN GERM-PLASM

ORGAN OF THE
AMERICAN GENETIC ASSOCIATION
WASHINGTON · D. C.

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SPECIAL NOTICE

Requiring the Action of All Members

Consider what you are paying for the *Journal of Heredity!* It is **Less than** most people allow for **one evening's entertainment.** Consider the relative returns!

Your membership fee in the Association is no larger than in other Associations but in this **you get a year's issue of an illustrated journal** containing **original photographic reproductions,** many of which represent **years of patient study by research men.** These *illustrations* are to be *found nowhere else except in expensive books* published later by these men.

Civilization is now entering a stage in which it is necessary that the human race have correct ideas of heredity. These matters are not to be dealt with by any system of prescriptions or directions to be handled by a few experts. They will require the most general comprehension of the facts that it is possible to secure. Although the importance of plant and animal breeding and eugenics is recognized, the public is not informed to the point of a practical understanding of the biological principles, or of the applications that are possible.

To get these correct ideas of heredity before the public the students of the subject must be heard and the photographs arranged by them must be seen. It is the most difficult thing in the world for anyone but the discoverer himself to place the facts correctly before the world. **This Journal contains the opinions of the real students—not the exaggerated interpretations of professional journalists.**

It is true that these articles require study to understand them, **but is any really valuable knowledge acquired sleepily?** Do not your school days teach you that? The articles in the Journal are written to **attract those who want to learn the facts about heredity.** The photographs attempt to explain the text; the **illustrations are unique and if studied will bring the reader right up to the fascinating borderland of knowledge regarding life.**

The scientific men who are working to make this Journal a success are **giving their time and articles without pay.** They do not have the money to give, for as you know such workers are still underpaid. They want to **make the Journal self-supporting.** They have seen the membership grow from its small beginning to its present size. It has come through the war, and has increased its membership 15 per cent this year. It now goes to members in 29 different countries of the world. **But it costs twice what it did before the war to publish the Journal.**

A little effort by each member now would make this Association large enough to be *a permanent meeting ground between the students of heredity throughout the world and the general public.*

From those who have youth and enthusiasm we want members. From those who have money we ask for bequests or direct financial support.

Nominate by letter those who ought to be members. **See back cover.**

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. XI, No. 4 April, 1920

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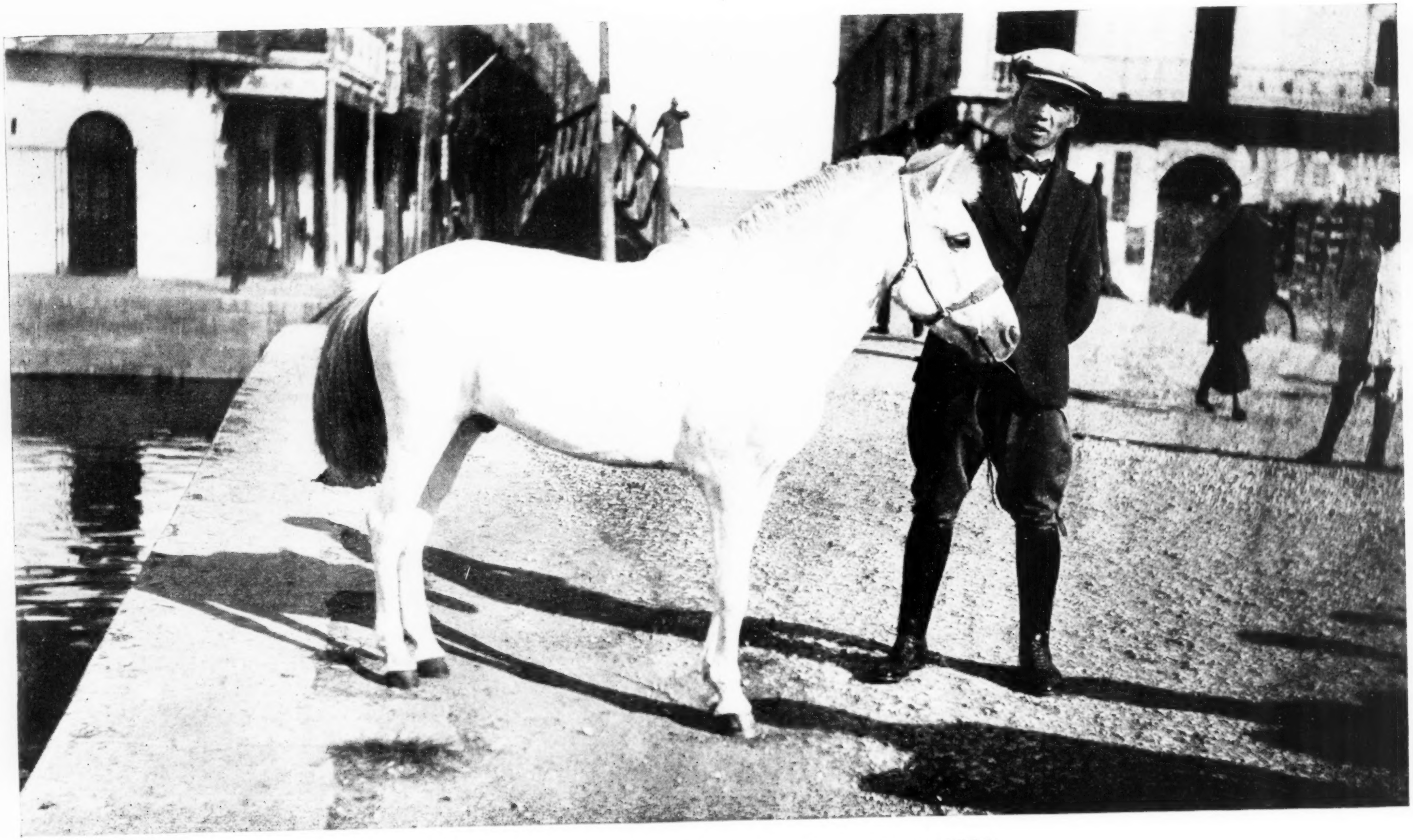


A NATIVE CHINESE OR TIBETAN PONY AT CANTON

Its native home is in Tibet and along the western border of China, and it is particularly well suited to the needs and conditions of those regions. Horses are used there chiefly for riding and pack carrying, and the soundness of the native pony, combined with its lightness, make it well adapted to the narrow roads and suspension bridges. (Frontispiece.)

NATIVE HORSES AND CATTLE IN THE ORIENT

Future of the Livestock Industries of China Outlined—Possibilities for Development of Great Meat and Dairy Resources if Modern Methods of Care and Breeding Are Introduced

C. O. LEVINE

Associate Professor of Animal Husbandry, Canton Christian College

HORSES, donkeys and mules have been little used in China, except in the northern and western provinces where they are used almost solely as pack animals and for riding. The southwest and western border of China, and Tibet, is the native home of the Chinese pony, which in literature is referred to as the Tibetan pony. Up to the present time no horses have been raised in Kwangtung. Horses from the western provinces are shipped to Kwangtung chiefly from Yunnan. The Chinese, or Tibetan pony, is an excellent pony for this region. It thrives well in this climate, and its size—it usually weighs about 500 pounds—is well suited to the narrow roads and "coffin-board" bridges. It is a beautiful animal, and the better ones are intelligent and easily trained by one who understands horses, provided the horses have not been previously spoiled by improper handling. They have good enduring powers, and seem quite free from diseases and unsoundnesses. They have colors common among other horses—black, white, sorrel, bay, piebald, gray, white, iron gray, with bay predominating.

THE MONGOLIAN HORSE

The Mongolian horse is quite common in the north of China. It is considerably larger than the Chinese pony, weighing about 700 to 800 or more pounds. It is of interest to students of horse breeding because of the fact that it is supposed to be the ancestor of most of our modern breeds of horses. It is raised in Mongolia in a semi-wild manner, much as the mustangs or Indian ponies were raised in the United States on the western plains up to recent years. It is a strong and swift horse, and is said to be fairly free from diseases, but does not do well in the south. As a rule those observed by the writer have not appeared as handsome as the Chinese ponies. It is the horse that is used in the annual races of Shanghai and Hongkong. It is not very popular in Canton, where there are only about 50 Mongolian horses as compared with about 250 Chinese ponies.

HORSES IN CANTON

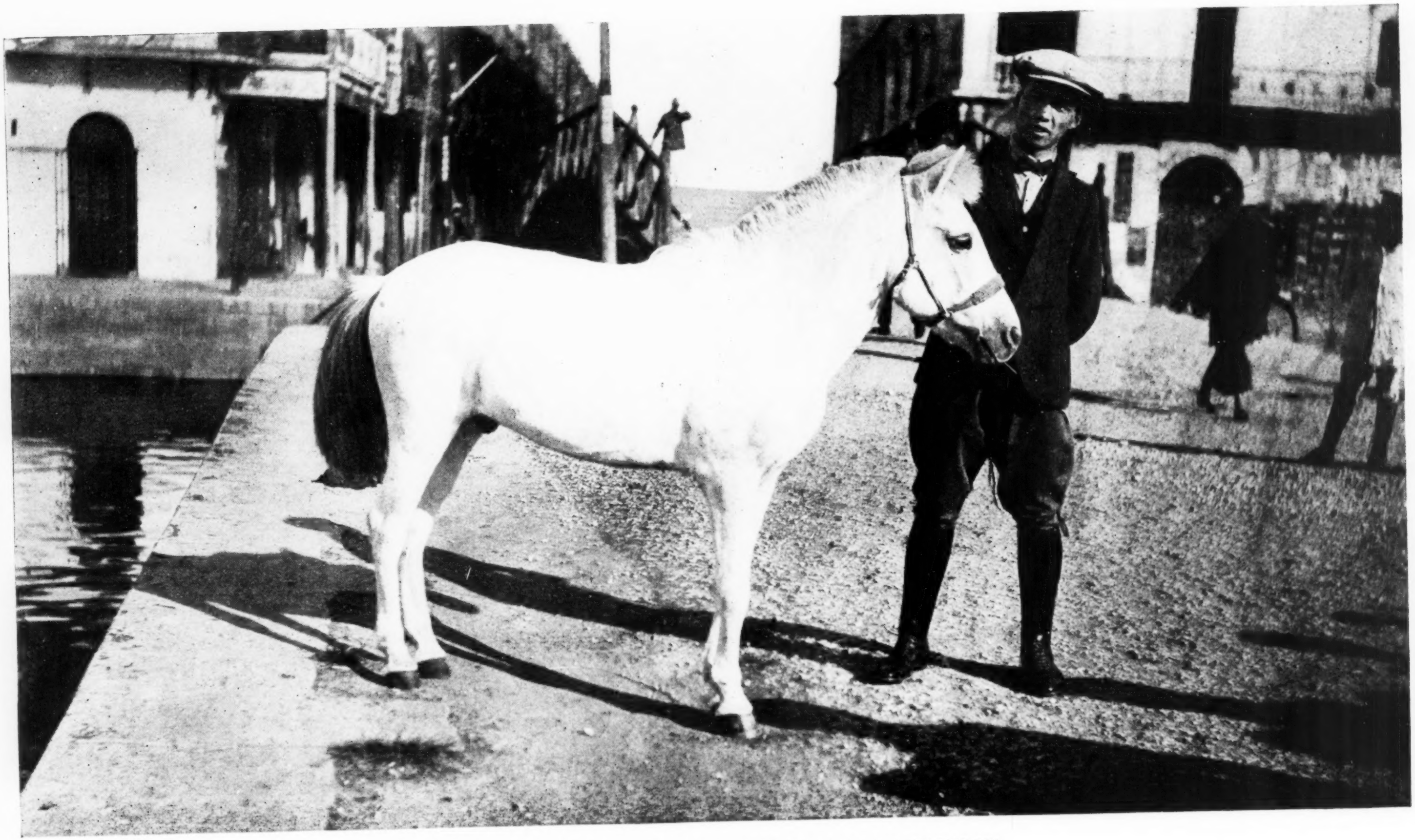
While the number of horses in Canton is at present small the demand for horses for riding and carriage use in Canton is rapidly increasing. Some of the livery barns recently have imported mares from the western part of China and have begun to raise ponies in Canton. There are few mares in Canton other than those recently imported for breeding purposes. The males are seldom castrated.

As a rule the Cantonese take good care of their horses, keeping their animals in good condition.

The usual concentrated feed for horses in Canton is corn, rice chop, and wheat bran. Green grass and rice straw are fed as roughage. The grass and straw are usually cut into short lengths before feeding. Rice is always cooked for the horses, as well as for other classes of livestock.

CHINESE CATTLE

Shantung, Chihli, and Honan provinces in the north, and Szechwan, Yunnan and Kwangsi provinces in the southwest, produce cattle in largest



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Shantung, Chihli, and Honan provinces in the north, and Szechwan, Yunnan and Kwangsi provinces in the southwest, produce cattle in largest

numbers. Conservative estimates would place the number of native cattle at 50,000,000. The total value of these at $30.00 (Mex.) a head would be $1,500,000,000 (Mex.). The export of cattle from China to other countries is small but is increasing from year to year. According to the customs reports, exportation has increased from 1,000 to nearly 100,000 cattle a year during the past four years.

Shantung is one of the biggest cattle producing provinces in China. The Japanese report referred to above has the following to say about the cattle in this region:

"Generally speaking the Shantung cattle are large in build. As for the ox, it usually weighs from 600 catties (1.33 pounds equal one catty) to 1,000 catties, with well developed loins and legs which almost form a rectangle shape. According to a native, a German missionary once imported here cows of a foreign breed with which he undertook the improvement of cattle in this locality, and that was the foundation of our cattle of the present day. . . . Judging from the fact that the Shantung cattle have a comparatively thin hide and have a tendency to early growth and fattening, we can safely infer that they are not a pure breed but improved species. Most cattle now in Shantung were brought over from Honan. Although they are called Shantung cattle there is no doubt but that they are the product of Central China. That is to say, they have gradually migrated eastward from Honan, Shonsi, Shansi and Kansu which are situated in the center of continental China. The Yellow River which passes through these territories makes the vicinity of its water course unfit for cultivation by the tremendous overflow of the river which takes place every year. In consequence the district forms one vast pastureland of thick weeds. Any person going through there will notice the thriving industry of cattle raising. As explained above the territories from which Shantung cattle come cover vast areas and naturally the number of cattle available may be said to be almost limitless.

"The method of raising cattle is very simple. In the country districts it is not uncommon for one to find from thirty to sixty head in one small village. Every farmer usually keeps from five to six head which are usually taken care of by one coolie. When cattle are not employed they are turned loose on the fields where they feed as they like. The coolie usually is a young lad who is called 'Cattle watcher.' His wage is usually 5 to 6 sen per day. At night he sleeps in the cattle shed. Cattle are fed three times a day, morning, noon, and evening, during the busiest season of farming. In seasons when farming is not in full swing they are fed twice a day —morning and evening. The feed then consists of about 16 catties of straw and 4 catties of mixed feed a day. The straw fed is mostly millet, but wheat straw is fed also. In some places dry peanut stems and sweet potato vines are fed. The mixed feed mentioned above is composed of kaoliang, beans and the like, mixed with cut straw or hay and water.

"Although Shantung cattle may not be as good as Japanese cattle for beef, yet it is an established opinion that they are far better than Korean or Mongolian cattle. At the time of the German administration in Tsingtau efforts were made to improve the cattle. They always kept cattle of foreign breeds in their slaughterhouse with which they undertook to better the Chinese cattle. Promising calves were purchased by the authorities. When they were one year old the German doctors brought them together and held an exhibition. Prizes were awarded for good cows, which were later bred to cattle of foreign breeds. By means of such encouragement and others, the improvement of cattle in this district was induced."

THE NATIVE "HUMPED" CATTLE

The methods of caring for and feeding cattle in Shantung, described by the Japanese authorities, are the same as those generally followed by the Chinese. The feed, however, differs in the various localities. In the Canton region the grain fed is usually rice chop and wheat

TIBETAN OR NATIVE CHINESE PONY

The native Chinese ponies have all the varying colors that are common to other breeds of horses, but bay predominates. They weigh usually about 500 pounds, and possess strong powers of endurance. (Fig. 1.)

bran. The cattle in the Canton region are not as large as the Shantung cattle, if the Japanese estimates are correct. The average cow in the south weighs 500 catties, and the average bull 800 catties, though some individual cattle have been noted that weigh as much as 1,000 catties when fat.

The native cattle of southern China are of the humped species common in the Orient. In most of the natural histories they are called Zebus. The main difference between these cattle and the European cattle (Bos taurus) is in the enlargement or protuberance on the top of the shoulders. This prominence in the bulls sometimes is as much as ten inches above the level of the back. The females of the variety common in China have, as a rule, only a small enlargement on the shoulders. The meat in the hump is said to be of good quality. The breeds of a related species in India (Bos indicus) are characterized by a larger hump and by a heavy fold of skin which hangs like a curtain from the throat to the brisket of the animal.

The color of the cattle in China is much like the color of Jerseys. It varies from a yellow red to a brown red and almost pure black. Spotted or white cattle are not common, chiefly because the meat of an animal with white color markings is considered inferior. Fawn is quite a common color. The nostrils are black with a grey or mealy colored ring around the muzzle just above the nostrils. The tongue is black. It is a peculiar coincidence that all of the above color characteristics of these cattle are also true of the Jerseys. While the amount of milk yielded is very small—so small that cows are seldom used for milking—the fat content is high, varying from 5 to 8 per cent.

THE "HUMPED" CATTLE IN HONGKONG MARKETS

Although the cattle from different districts of southern China, are much alike in color and conformation, there is some difference in types in different communities.

There are three distinct grades of cattle, for instance, that reach the Hongkong market, coming from different regions. Those coming from the east coast of Kwangtung province, from the region south of Swatow, are superior in size and beef characteristics to those raised in the region of Canton, and their dressed meat sells on the average for 27 cents (Mex.) when Canton beef sells for 24 cents. Cattle from the west river region, or above Wuchow, are of a type just between the Canton and Swatow cattle. They are somewhat better than the Canton cattle, but not as good as those from the Swatow region. Cattle are sold by the head, and not weighed. The usual price for a fair individual weighing from 600 to 800 pounds is from $28.00 to $50.00 (Mex.).

THE FUTURE FOR LIVESTOCK IN CHINA

The production of better and more live stock in China must come as the country develops industrially and commercially. Good police protection, good roads and railways, a demand for export products and an increasing demand for milk, will all be incentives to expansion of the livestock industries. There is enough grass on the hills of China, now not being utilized except for fuel, to produce at least twice as many cattle as are being produced today. Cattle sell for about one-half the price they sell for in America. Better prices offered for export beef, which will come with development, will stimulate the beef industry, and the demand for milk within China itself must be met. With the present prices received for milk (12 to 18 cents local currency per pound) and the price at which imported butter is sold, ($1.20 local currency per pound) there are few other industries that offer better opportunities for young men well trained in the principles of dairying and breeding and with a thorough knowledge of the methods of producing sanitary milk, butter, and other dairy products.

IMPROVEMENT OF LIVESTOCK

With the development of agricultural industries will come a demand for the improvement of the different classes of livestock now raised in China. Three

methods of improvement suggest themselves.

The first method, and no doubt the best, is that of improvement within the breed, without the introduction of foreign blood. A few generations of intelligent selection of individuals for breeding purposes should greatly improve the cattle for beef purposes. Because of the small amount of milk given by native humped cows, draft and beef production will probably always remain the function of this class of cattle. Breeding for improvement without the introduction of foreign blood should be followed with all classes of live stock, no matter how extensive the use of modern breeds may become.

The buffalo in China has been chiefly a draft animal to be used for beef as soon as its usefulness for work is ended. In recent years some dairies in the south have begun to use the buffalo for milk, and now have cows that give more than 12 pounds of milk a day, testing from 10 per cent to 15 per cent fat. Six buffalo cows at the Canton Christian College, for which records for complete lactation periods are available, have produced an average of more than 250 pounds of butter fat.

A second method of improvement would be to introduce males of improved breeds for mating with native cows.

Crossing the native cattle with modern breeds of beef cattle should no doubt improve the native cattle for beef purposes. However, such crossing of native humped breeds of cattle with European breeds has not proven popular in the Philippines and in India for the reason that while the cross produces better beef cattle, such cattle are of little use for draft. The chief reason why the native cattle are so well adapted for work is because of the hump against which the yoke fits so well. In animals containing foreign blood the hump is very small, or not present at all.

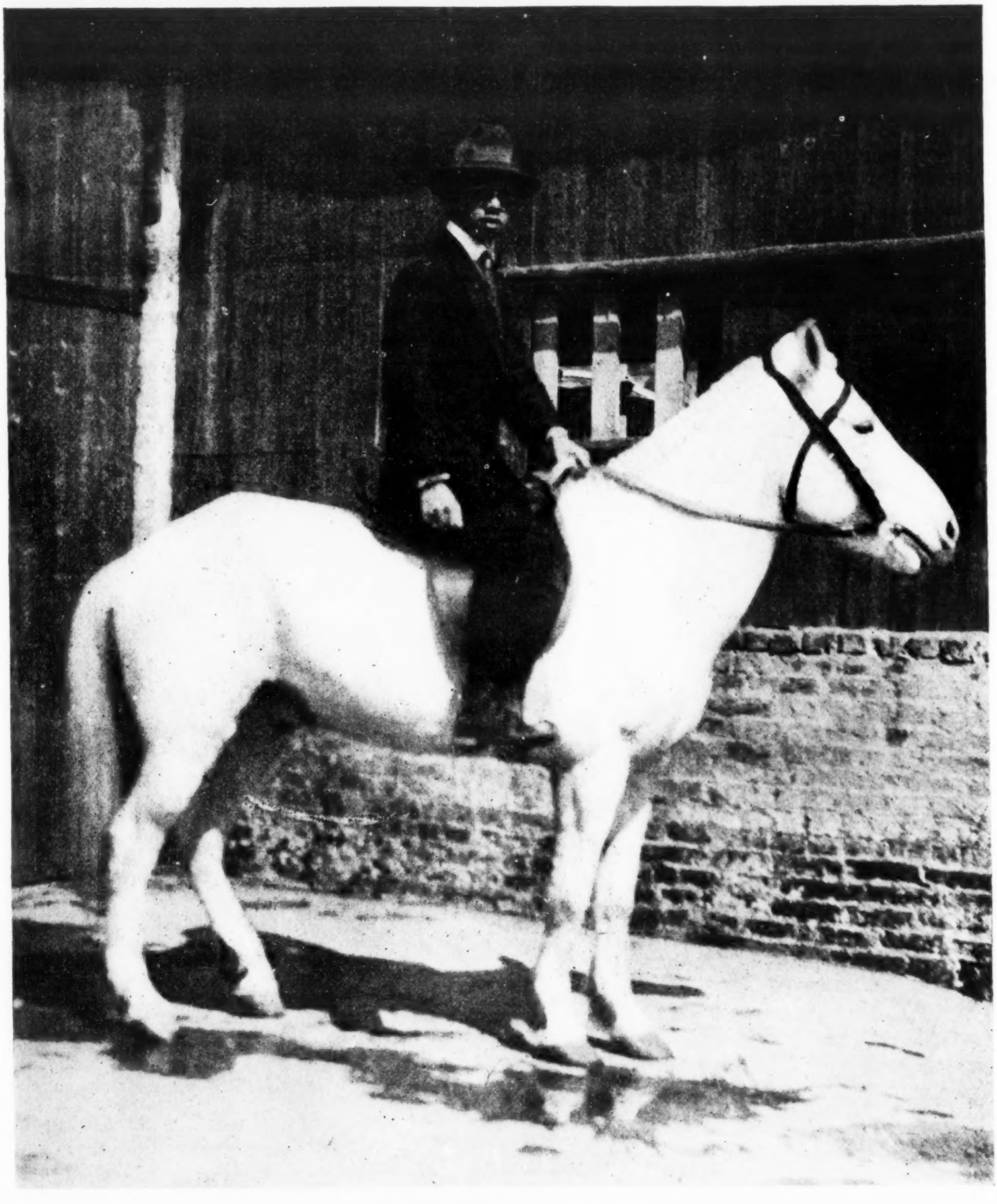
A third method suggested for improvement of native live stock is to secure pure bred animals of desirable breeds and continue to breed them pure.

The first method suggested, that of selection within the native breed for improvement, is safest, but slow in bringing results. Introducing modern improved breeds will probably bring quicker results, provided good, healthy individuals only are secured and intelligent breeding is practised. However, the disease common here, and not common in regions from which imported cattle come, should be taken into consideration and guarded against, or the result to individual breeders is apt to prove disastrous financially. Great care should be taken not to introduce tuberculosis with European breeds.

NEED OF TRAINED LIVESTOCK MEN AND VETERINARIANS

Men trained in animal breeding and feeding, are much needed in China to improve the quality of livestock by intelligent feeding, care, selection and breeding, and by introduction of foreign breeds. Veterinarians are needed to take up a thorough study of diseases and their control, and to build laboratories for the production of anti-cholera and anti-rinderpest serums for the prevention of these two great plagues of the livestock industry. Canton, like all cities in China, is in need of government livestock sanitary inspectors with adequate laws to support them, to prevent the sale of diseased meat, and above all the sale of unwholesome milk; for while the danger of eating diseased meat is serious enough, the danger of contracting typhoid fever, tuberculosis and other disease from contaminated milk is apparent to all. Every cow with European blood, whose milk is being sold to the public, should be tested for tuberculosis and reacting animals be rejected for dairy purposes. Such work is the work of a veterinarian. It should not be necessary to test native cows or buffalos, as the native cows are highly resistant and the water buffalo apparently immune to tuberculosis.

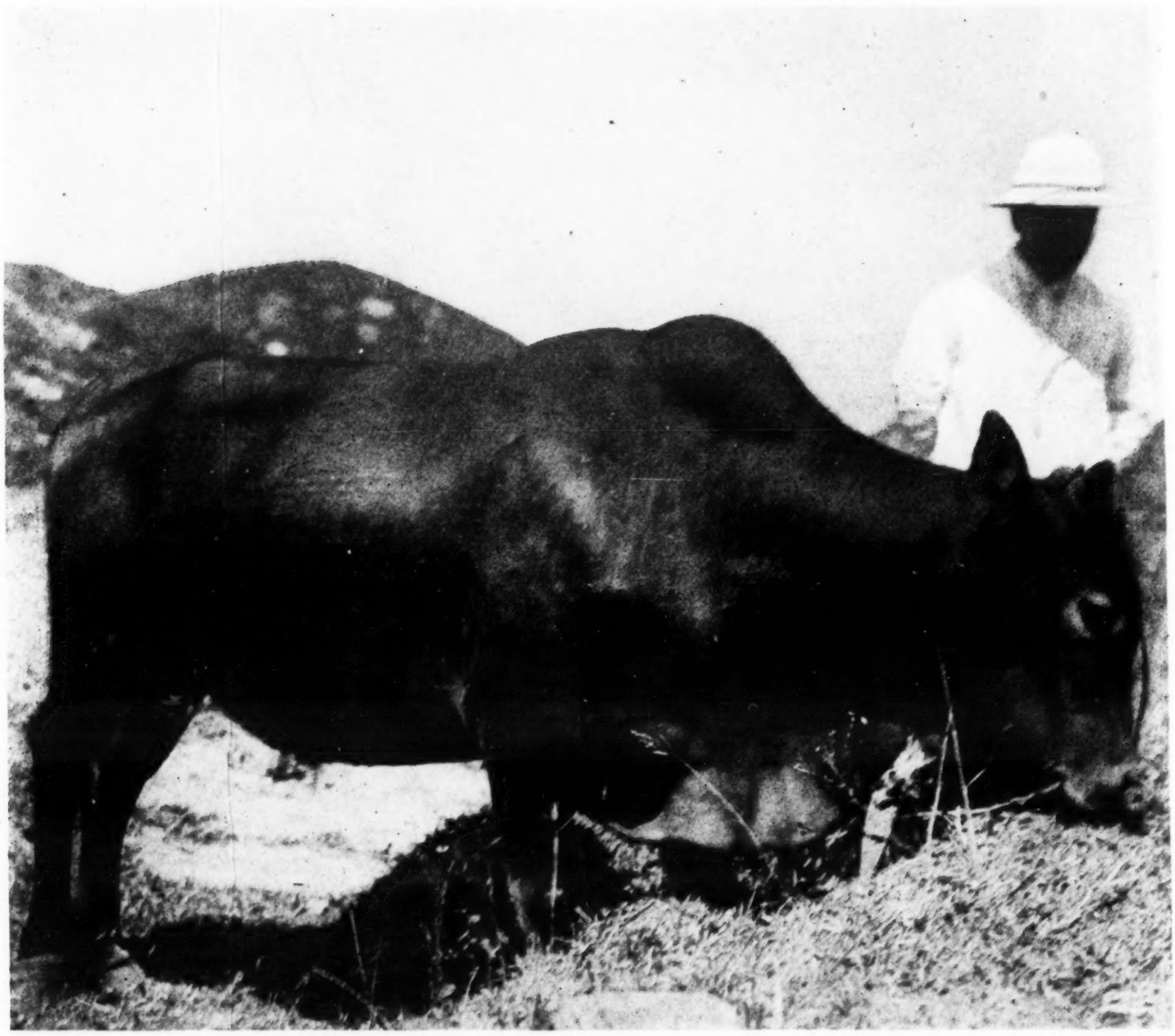
Some of the dairies have good bulls of modern dairy breeds, but cannot produce good milkers because of their methods of raising calves. From the time the calves of these European cows are born they are kept tied up in a



A MONGOLIAN HORSE

The Mongolian horse is much larger than the native Chinese pony, weighing from 700 to 800 pounds. It is said to be the ancestor of most of our modern breeds of horses. It is common in the north of China, but does not do well in the south. In Canton there are only one-fifth as many Mongolian horses as there are native ponies, but the former are the horses used in the races at Shanghai and Hongkong. (Fig. 2.)

barn and are never turned out, even in a dry lot, to exercise. Naturally, the cows in even the best dairies are poor milk cows, small in size, some with every indication of tuberculosis, and giving an average of from 15 to 20 pounds of what is very probably contaminated milk each day, while if



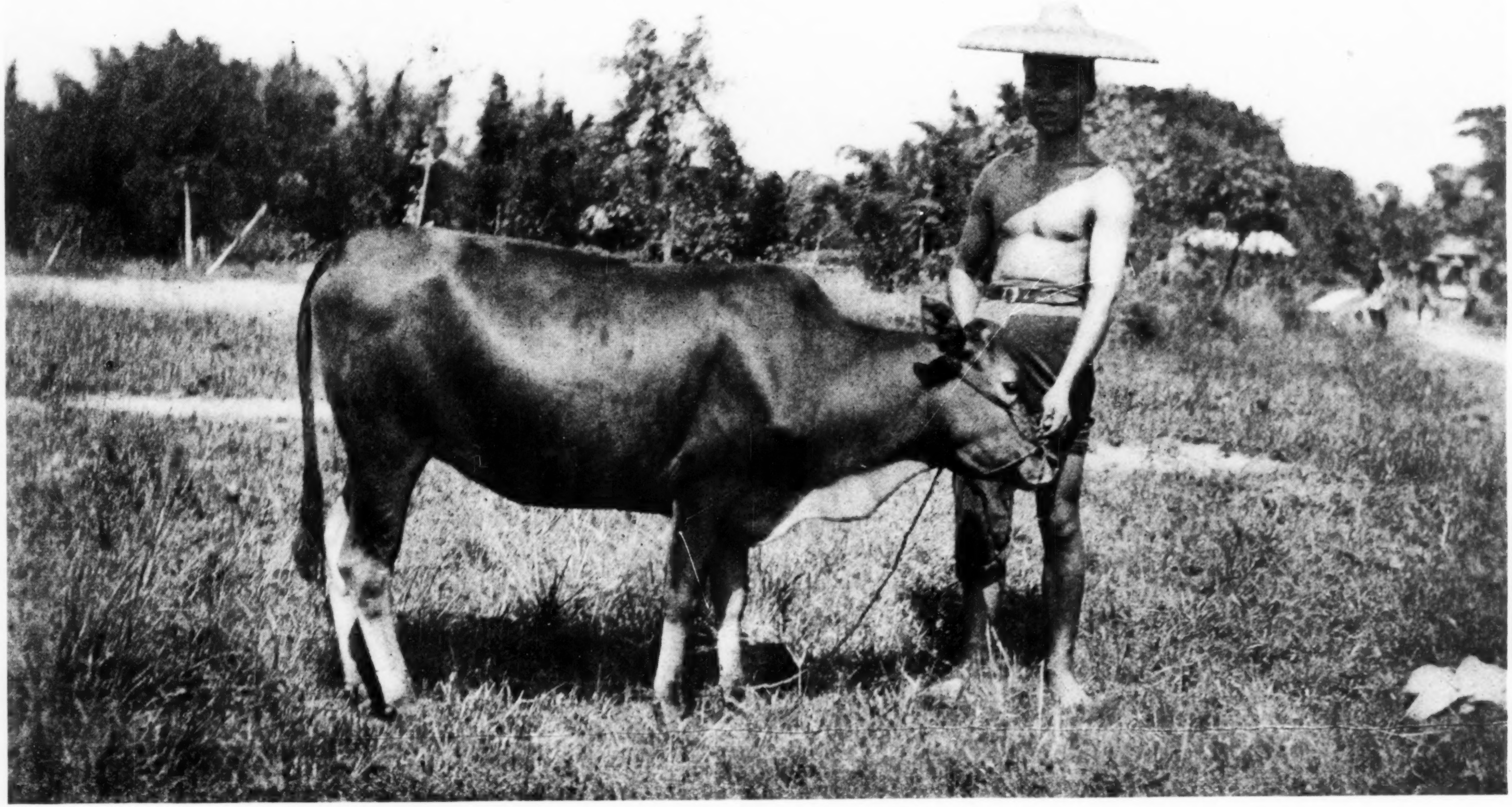
A NATIVE CHINESE BULL

The native cattle of China possess an enlargement or "hump" on the shoulders which is characteristic of cattle in the Orient. That is their main difference from European breeds. In bulls, the enlargement is sometimes ten inches above the level of the back, but in the females it is very much smaller. (Fig. 3.)

properly cared for they might give from 20 to 30 pounds of good wholesome milk.

STANDARDIZING MILK

Many dairies at present add water to the milk they sell in order to increase their profits. The danger of disease germs from the use of impure water is apparent, to say nothing of the unfairness to honest dairymen. Milk offered for sale should be analyzed for fat with a Babcock tester and a check be kept on watering milk. Buffalo milk containing less than 10 per cent fat and European cows' milk containing less than 3 per cent fat is undoubtedly watered milk. Dairymen found guilty of adding water should be heavily fined. Repetition of the offense should cancel the right of such a dairy to sell milk to the public. Buffalo milk should be sold for at least twice as much as foreign cow's milk, in order to remove the temptation to water such milk. It would, at such a price, be no higher in price for the food value it contains than foreign cow's milk, and based on per cent of fat, would be far cheaper. It is hoped that modern methods can soon be applied to the dairy and other animal industries of China, so that



A HEIFER OF THE NATIVE HUMPED SPECIES OF CHINESE CATTLE

In color and general markings these cattle resemble the Jerseys. The amount of milk yielded, however, is so small that cows are not often used for milking. The milk, however, has a high fat content, varying from 5 to 8 per cent. (Fig. 4.)

there will be a more efficient use of the country's wonderful resources.

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Were the Black-and-White Holsteins Originally Red-and-White?

There was recently born on the University of Idaho farm a pure-bred Holstein bull calf which was red-and-white in markings. This calf is the first calf of a heifer and it so happens that it is also inbred, that is, the sire of the calf is the sire of the dam. There is also evidence to the effect that this sire is the sire of another red-and-white calf out of a purebred Holstein cow, although this instance did not occur on the University of Idaho Farm.

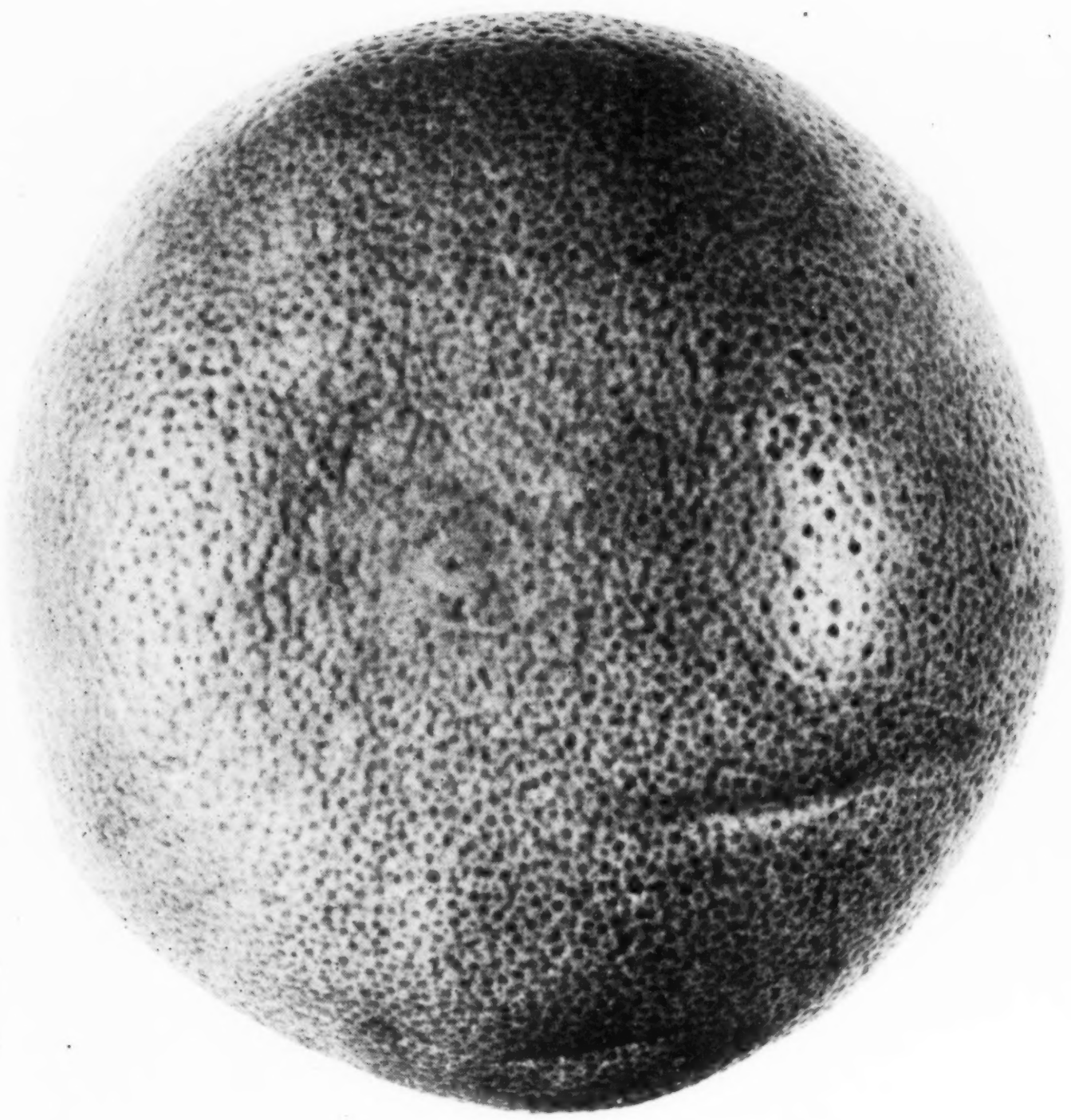
Instances have occurred of red-and-white calves having been dropped from pure-bred Holsteins in this country but, because they are ineligible to registry, usually no record is kept of them; in fact, breeders are likely to conceal the fact, thinking that it will be a criticism of their herd. There is evidence to believe that the Holstein-Friesians in Holland have been crossed with a red-and-white stock; in fact, the ancestors of the Holstein were very likely red-and-white.

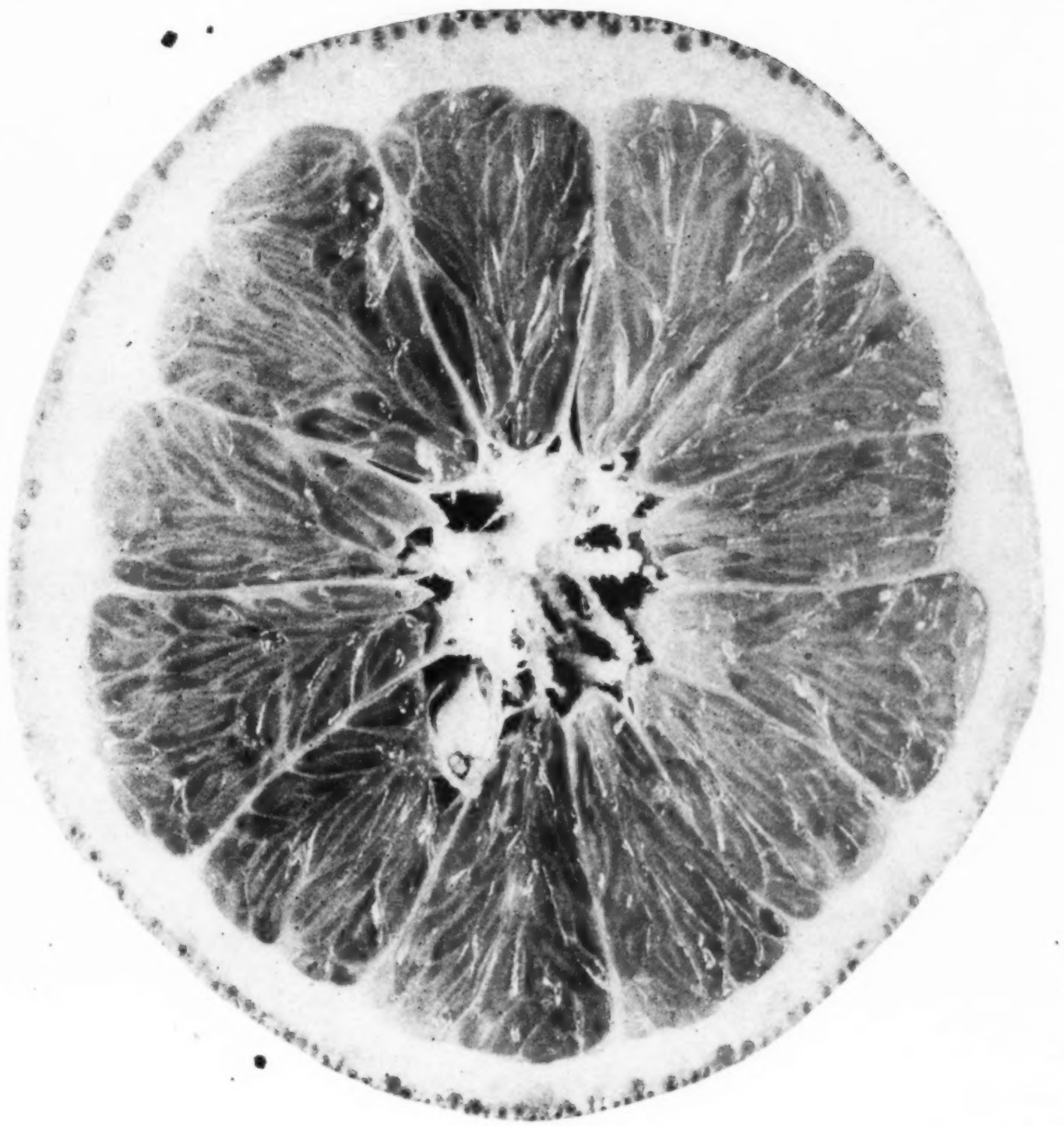
We are interested in finding out as much data as we can regarding this inheritance of red-and-white color in Holsteins; consequently, we should be glad if any readers of the JOURNAL can enlighten us further with reference to the problem. We should particularly like to get in touch with anyone having a red-and-white heifer.—H. P. Davis, College of Agriculture, Moscow, Idaho.

Death of W. Schallmayer

In the death of Wilhelm Schallmayer, recently announced, Germany has lost one of her most eminent eugenists, a man who had devoted most of the active years of his life to spreading the application of genetics to human society.

In 1900 he published the first edition of his book, "Heredity and Selection," as a prize essay. The third edition, almost entirely rewritten, was issued in Jena in 1918.





A PINK-FLESH MARSH GRAPEFRUIT SPORT

Cross-section and blossom-end view. This fruit was taken from a limb of a Marsh tree in the L. V. W. Brown orchard near Riverside, Cal. "It was found that these pink-flesh fruits were borne by a single large branch in a typical Marsh grapefruit tree." The pink color was faint in the flesh, except near the rind, but conspicuous on the outside. (Fig. 5.)

ORIGIN OF A GRAPEFRUIT VARIETY HAVING PINK-COLORED FRUITS

A. D. SHAMEL
Riverside, California

AN INTERESTING illustration of the origin of citrus varieties from bud variations is found in the development of the Foster grapefruit. This variety was introduced by Reasoner Brothers of Oneco, Fla. As to its origin, Mr. E. M. Reasoner writes under the date of August 6, 1915: "This is a sport from the old-fashioned variety Walters. The Walters tree is growing in the Atwood grove near us, and the one limb that has pink-fleshed fruit is of good size, say 4 or 5 inches in diameter, and bears considerable fruit. About seven-eighths of the tree is Walters, the one limb only being Foster."

In their catalog for 1919 the Reasoner Brothers state in their description of this variety that it is identical with the Walters variety, from a tree of which it is a sport, except in the color of flesh. A description of the fruit is quoted from Governmental Pomological Notes as follows: "Next to the skin the flesh is a light purplish-pink color which shades to a clear translucent color at the core; there is very little pulp." In this same catalog Prof. Hume, the noted horticultural authority of Florida, is quoted as writing "my opinion of the Foster grapefruit is that it is a fine fruit. It is the best early grapefruit that I know of. It was in good eating condition at Winter Haven (Fla.) earlier than any other variety we have tested, and I think we have them nearly all."

The writer has not had the opportunity of studying this variety in Florida. He has observed young trees and fruits of this variety in Arizona in an orchard located near Phoenix during the month of December, 1918. The fruit from these trees, particularly the distribution of color in the flesh, resembled closely the above description in Florida grown fruits. The outside of the rind of the Foster grapefruit grown in Arizona, at the time they were examined, showed faint but unmistakable traces of pink color. In a comparison of the eating quality of this Foster fruit with that of other grapefruit varieties, including the Marsh, the writer's notes indicate that it was inferior and less desirable than that of the Marsh or the other varieties tested.

In Figs. 7 and 8, recent photographs are shown of Florida grown Foster grapefruit; these photographs were furnished to the writer by Mr. Walter T. Swingle. Some of the characteristics of these fruits and the leaves from a tree of this variety can be identified in these illustrations. Fig. 6 shows a typical Foster grapefruit tree.

The history of this variety furnishes another instance of the origin of a horticultural variety from a bud sport.

In July, 1919, the writer's attention was directed, by Mr. L. V. W. Brown, to a pink-flesh sport in a Marsh grapefruit tree near Riverside. It was found that these pink-flesh fruits were borne by a single large branch in a typical Marsh grapefruit tree. An inspection of the pink-flesh fruits borne by the same tree revealed the fact that, aside from the color of the flesh and the rind, the two fruits were as nearly identical as any two Marsh grapefruits usually are when taken from different branches of the same tree. This branch has been known to produce pink-flesh grapefruit for at least three years. Buds have been taken for propagation

A FLORIDA GROWN FOSTER GRAPEFRUIT TREE

This variety is a sport from the Walters variety and its fruit is identical with that of the latter except in the color of flesh, which is slightly pink near the skin. (Fig. 6.)

in an experimental way from this branch, but no trees grown from such buds have come into fruiting as yet. In this instance there was but faint trace of the pink color in the flesh anywhere except near the rind. On the outside of the rind the pink color was rather conspicuous, so much so, in fact, as to unmistakably mark the fruit. Fig. 5 shows a typical fruit of the California grown pink-flesh Marsh grapefruit sport.

Other instances of pink-flesh citrus fruit varieties originating from bud sports have been reported. Additional data concerning them is being collected as opportunity permits. The writer would appreciate any further facts concerning this phenomenon, for the purpose of completing the evidence as to the origin of other varieties of the citrus bearing pink-flesh, red, ruby or other strikingly different colored fruit from that of the established varieties bearing fruit possessing the normal color of flesh and rind.

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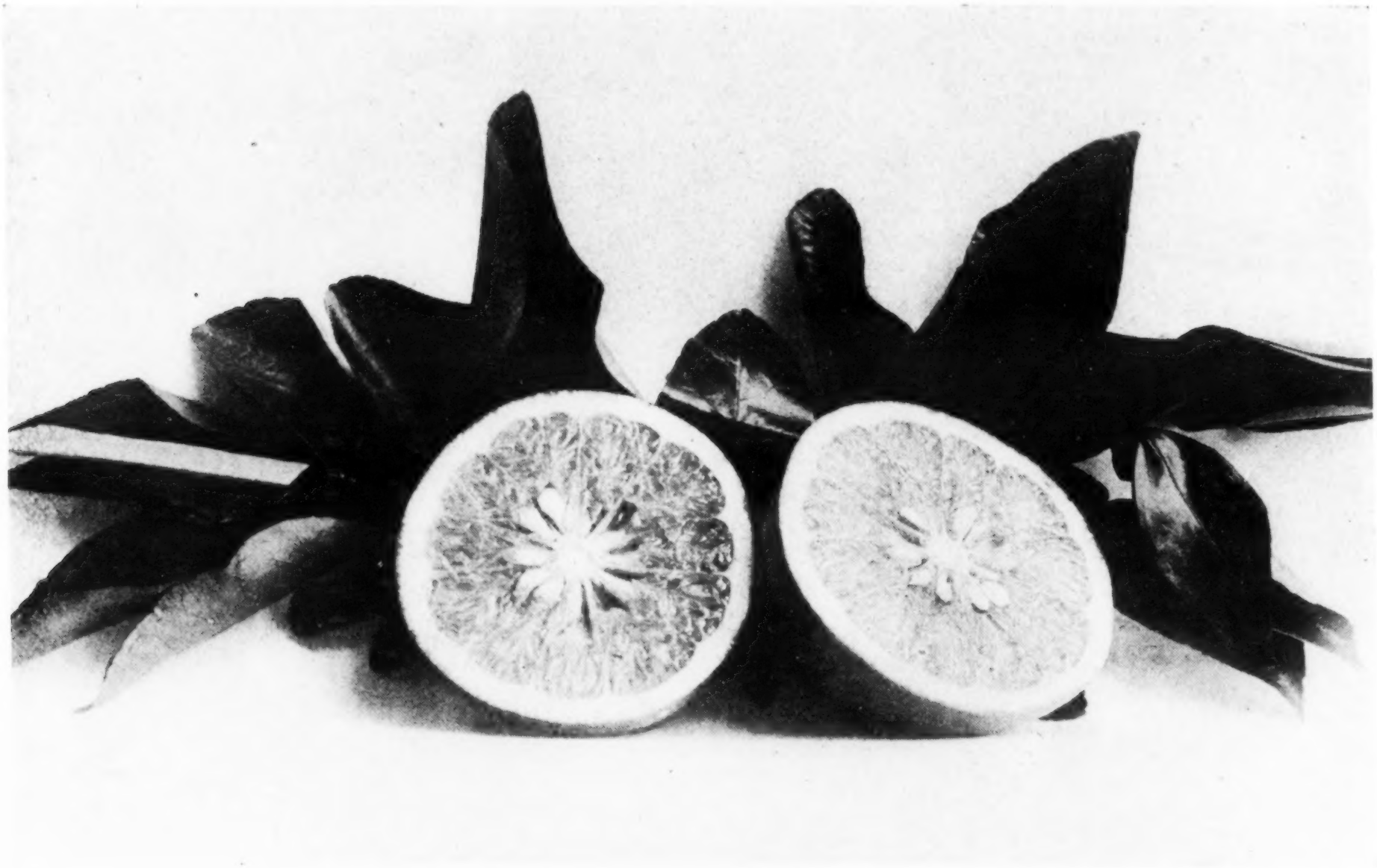
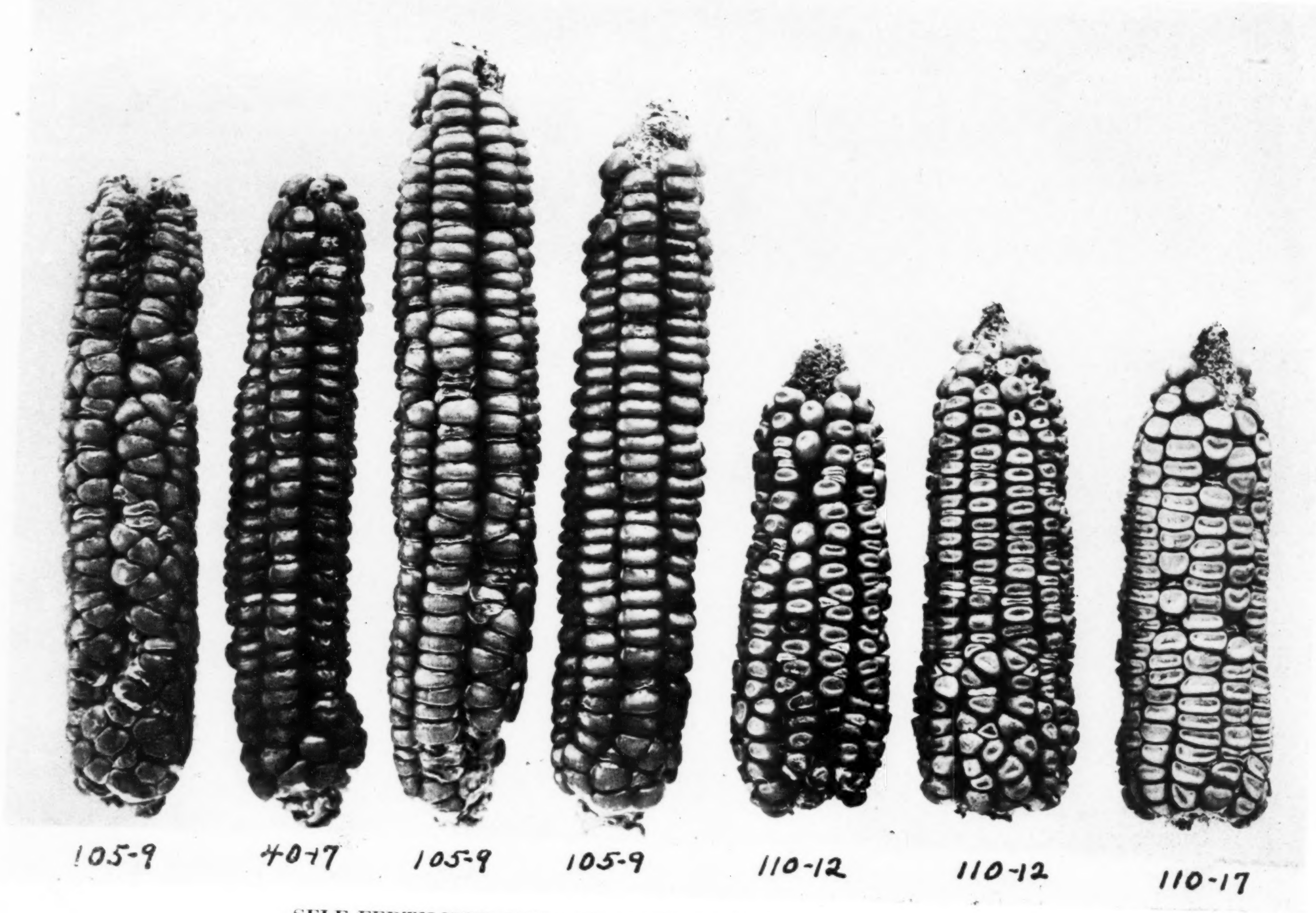
TYPICAL FLORIDA GROWN FOSTER GRAPEFRUIT

Showing the shape of the fruit, texture of the rind, and other characteristics, together with the shape and other characteristics of the leaves from a Foster tree. (Fig. 7.)



CROSS-SECTION OF FLORIDA GROWN FOSTER GRAPEFRUIT

Showing the thickness of the rind, arrangements of seeds, and other characteristics. The pink color of the flesh, of course, does not appear in this photograph. (Fig. 8.)



SELF-FERTILIZED EARS OF MAIZE SHOWING DEFECTIVE SEEDS

The ratio of defective to normal seeds in each of the above ears is given in the Table on page 166. The ears labeled 110-12 and 110-17 are descended from the ears labeled 12 and 17 in Fig. 15. (Fig. 9.)

HERITABLE CHARACTERS OF MAIZE

IV. A LETHAL FACTOR—DEFECTIVE SEEDS

D. F. JONES

Connecticut Agricultural Experiment Station, New Haven.

LETHAL factors are familiar in corn in the form of several different kinds of chlorophyll deficiencies. White and virescent seedlings represent heritable characters which stop growth as soon as the food stored in the seed is exhausted. Golden plant color and many forms of striping permit growth and reproduction, but at a reduced rate.

A new factor, which shows itself in the form of aborted seeds with either entirely empty pericarps or badly shriveled seeds, has been found, being completely lethal in its action in some cases and partially so in others. Development of both the embryo and endosperm is stopped completely or greatly reduced shortly after fertilization. However, the fertilization process is sufficient to start the pericarp, and this developes unchecked to very nearly as full an extent as if the contents were present, although the empty hulls are greatly compressed by the crowding of the normal seeds adjacent. Fortunately the growth of the pericarps makes the distribution of the abnormal seeds easily apparent. The behavior of this character indicates that it is recessive and due to a single factor difference. This gene is called *defective seed* and is designated *de*.

OCCURRENCE OF DEFECTIVE SEEDS

Attention was first called to this condition by some ears of corn grown on plants of ordinary field varieties which had been self-fertilized for the first time. A considerable number of plants of four varieties chosen as among the highest yielding sorts in this locality were raised. Two of these were dent and two flint varieties of rather distinct type and have been widely grown in the state.

Altogether about 75 selfed ears were obtained from the four varieties, and in three of these 8 ears were found which were definitely segregating into normal and defective seeds. After such a factor was once recognized it was noted in many other kinds of material from widely different sources. It has also been noted by others working with corn. It has been detected in several different types of popcorn, in sweet corn, and in locally grown varieties as well as in tropical sorts, so that unquestionably it is widely distributed and may occur in practically all kinds of corn. In field-pollinated plants cross-fertilization tends to keep the character hidden from sight. Chance recombination allows a few seeds to appear on plants heterozygous for the abnormality, but since a few abortive seeds are common on nearly every ear of corn, due to various causes, such seeds pass without particular notice.

When the plants are self-fertilized, then if the genetically defective seeds are present at all they appear in approximately 25 per cent of the seeds and, because of their greater numbers and distribution over the entire ear, they show up plainly. The character is manifested in several different degrees and it is not yet certain that they are all due to the same factor. This remains to be seen, but that there is a definitely inherited factor there can be no doubt. The difference between the recessive seeds and the normal seeds on the same ears is usually pronounced, and classification can be easily made.

DESCRIPTION OF THE CHARACTER

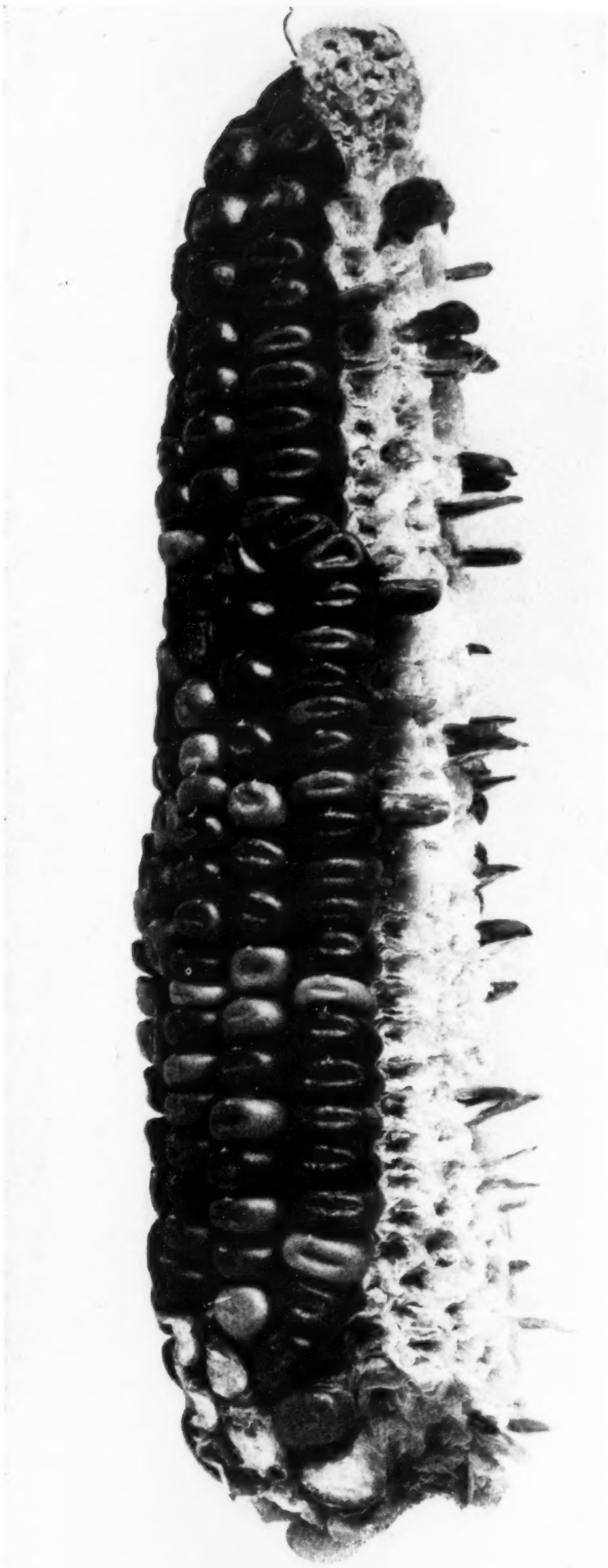
In its extreme manifestation the pericarps develop but are completely empty. Such unfilled capsules are distinct from partially developed ovules due to incompleted growth or ineffective

NORMAL AND DEFECTIVE SEEDS COMPARED

The defective seeds (right) are from the same ears as the normal seeds (left). In the specimen shcwn at the bottom the pericarps of the defective seeds are nearly empty, as indicated by their transparency. In the specimen at the top the defective seeds are partially developed but badly shriveled and shrunken. (Fig. 10.)

THE RESULT OF INCOMPLETE POLLINATION

In the ear at the left, the undeveloped ovules are clearly different from the defective seeds on the other two ears. The middle specimen shows the result of both insufficient pollen and hereditary deficiency. Photograph by R. A. Emerson. (Fig. 11.)



DEFECTIVE SEEDS

Some completely aborted seeds with a few partially developed ones are shown. The empty shells, flattened between normal seeds, are not conspicuous until the latter are removed. Photograph by R. A. Emerson. (Fig. 12.)

fertilization (Fig. 11). Where the empty shells occur between normal seeds they are flattened to a thin sheet and are inconspicuous until the seeds are removed from the cob. Then the aborted seeds stand out plainly, scattered over the rachis, as shown in Figure 12. In other segregating ears (as in Fig. 13) the defective seeds contain some embryo and endosperm material. Such partially developed seeds are small and usually very much shriveled (Figs. 10 and 14). In other cases the seeds are not shriveled but are smaller and have a dull opaque appearance quite distinct from the translucence of dent and flint seeds having corneous endosperm.

Where there is considerable material in the defective seeds they may germinate, but usually very poorly, and when they do, the seedlings are extremely weak, abnormal in appearance, and make a slow growth. In a few cases the seeds germinate well and the seedlings appear normal. Generally the seedlings are lacking in normal green chlorophyll color.

INHERITANCE OF DEFECTIVE SEEDS

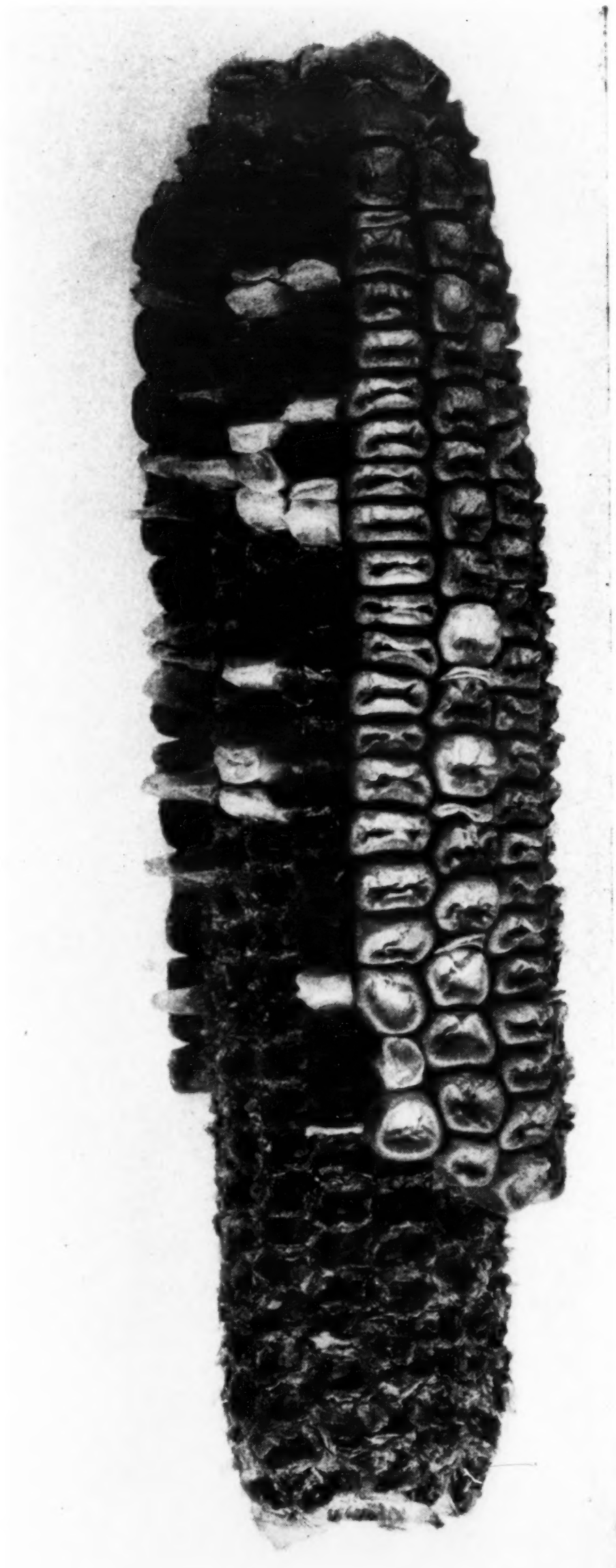
The normal seeds of the 8 segregating ears were planted and again self-fertilized. In every case the same condition appeared in some of the ears of the progeny, as shown in the Table. In addition, 5 ears which were not considered to be segregating also gave clearly segregating ears in the progeny. All the ears were examined for this character while they were being shelled off, but no defective seeds in sufficient amounts on these parent ears were seen to classify these five ears at that time as segregating. However, a photographic record of the original ears was made and this shows that three of the specimens were probably segregating. At least a few defective seeds can be seen, although the numbers are small. The remaining two ears show no signs of defective seeds and the ears are well developed, with about 500 seeds on each. Yet one clearly segregating ear was found in each of the two progenies in a total of five and six selfed ears in the two lots. This small number of segregating ears,

where they should occur in the ratio of two segregating plants to one normal, together with the fact that the parent ears were normal, indicates that a more complex situation may exist in this particular material.

The numbers obtained from all the ears together show the recessive seeds to be fewer than the expected numbers based on a single factor difference. A number of non-segregating ears in the same lots as the ears showing the defective seeds, as well as normal ears from unrelated sources, were examined, and from 1 to 5 per cent of partially developed seeds were found on many ears which might easily be included in the defective class. Therefore if the recessive seeds were in excess as much as 30 per cent instead of the expected 25, this would not be thought unusual. But the deficiency in numbers is clearly due to some influence. It may be that a certain proportion of recessives do not stimulate the pericarp to develop sufficiently, or the active competition on a crowded ear may prevent development enough so that all the defective seeds are included in the count.

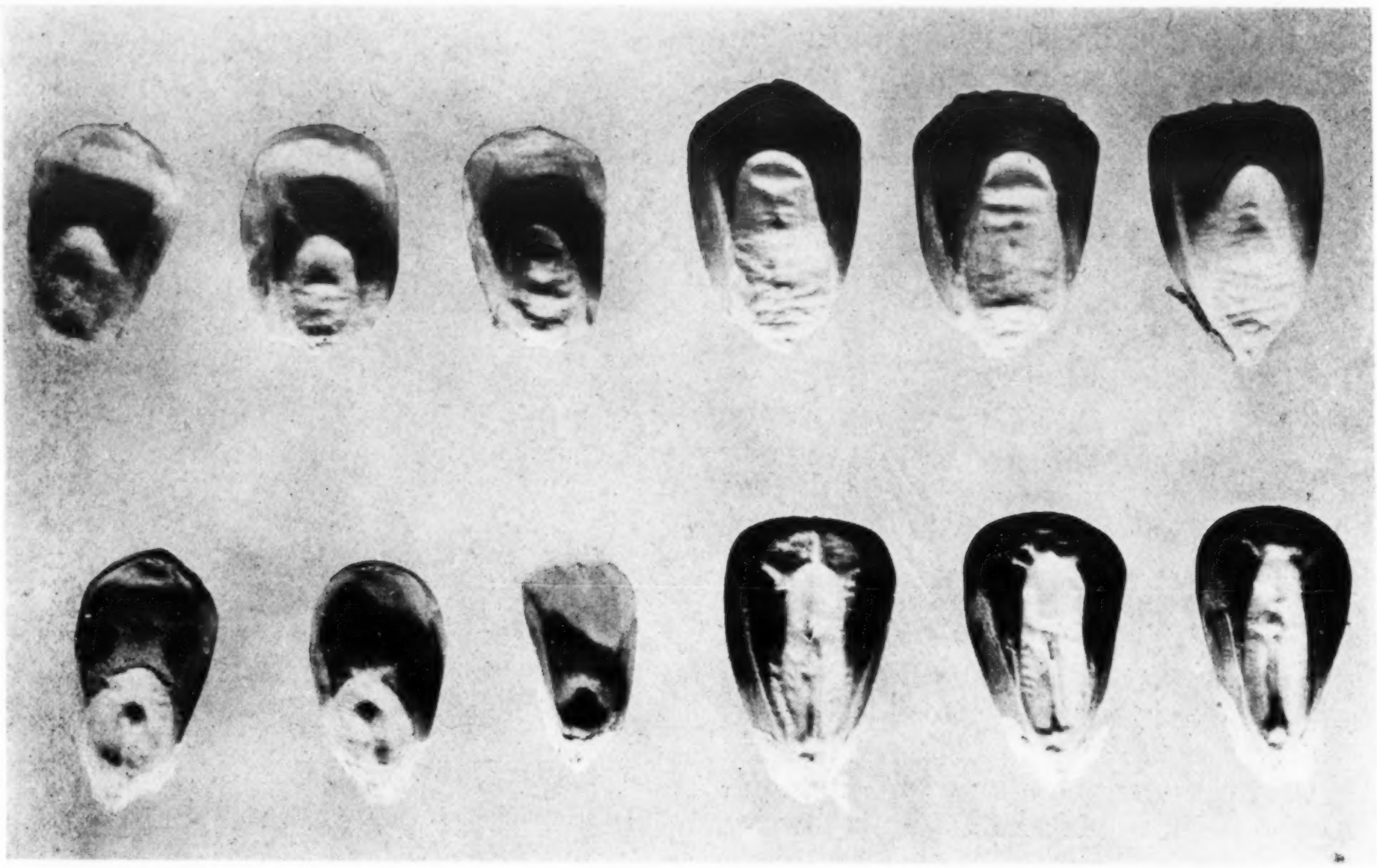
In the original lots of self-fertilized ears the segregating individuals are generally smaller and more poorly developed than the normal ears. This may be evidence that the same factor which prevents normal growth in the seeds in the homozygous recessive condition also reduces the vigor of the plants when in the hybrid condition. Further investigation is necessary to establish this, but the material all together indicates that this is the case. The defective seeds which will germinate have not been tested long enough to determine whether or not they are capable of completing their growth and reproducing themselves.

In Fig. 15, which represents the original lot of selfed ears of one variety, specimen No. 12 shows partially defective seeds, while in the one numbered 17 the recessive seeds are completely aborted. The empty shells of the pericarps only remain. In Fig. 9 some of the progeny ears of these two plants



PARTIALLY DEFECTIVE SEEDS

Showing a few seeds completely aborted. The "partially developed seeds are small and usually very much shriveled." Photograph by R. A. Emerson. (Fig. 13.)



NORMAL AND DEFECTIVE SEEDS

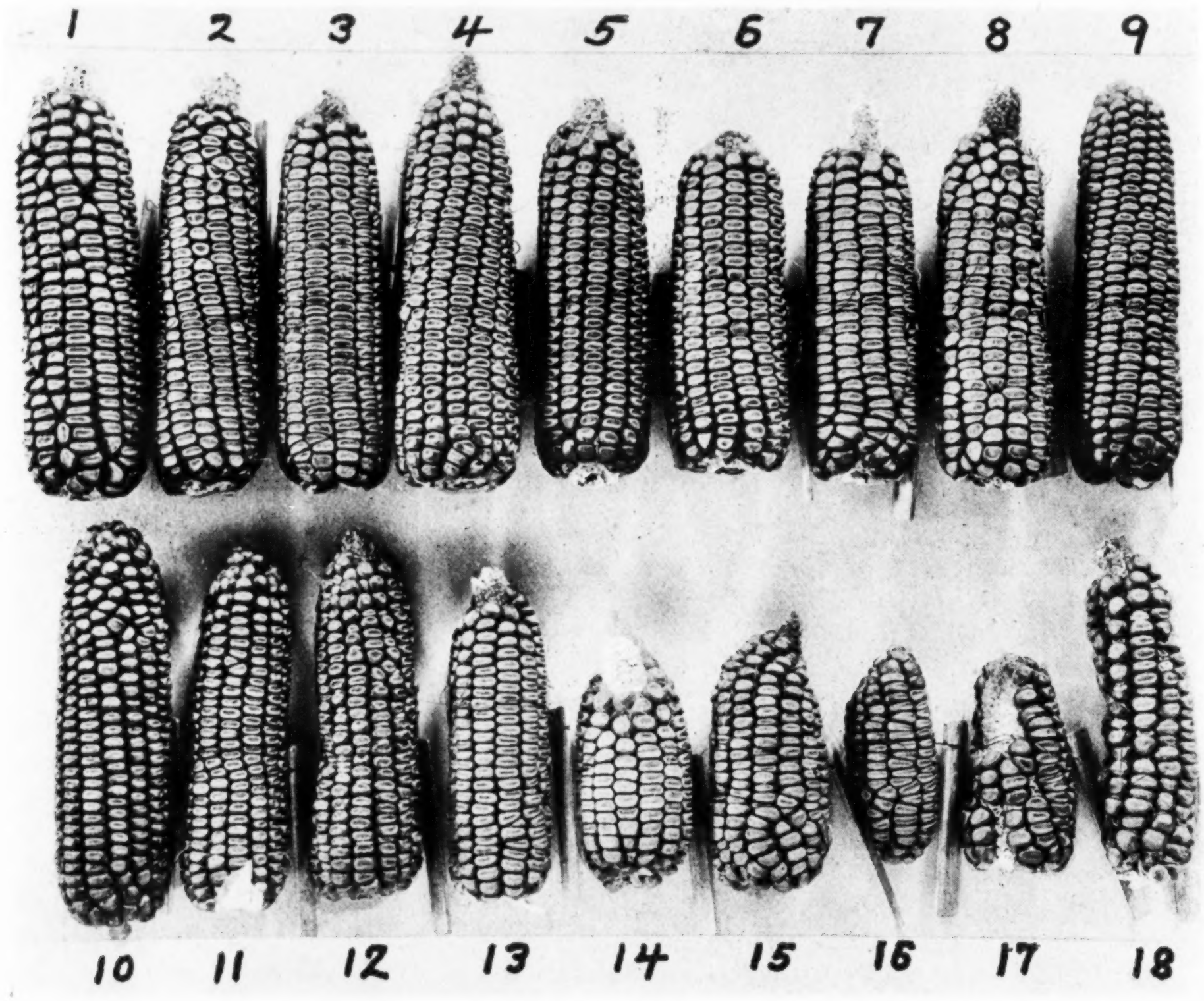
These seeds are from two segregating ears and show the differences in size of the embryo. In this case the defective seeds "are not shriveled but have a dull opaque appearance." Seeds furnished by R. A. Emerson. (Fig. 14.)

TABLE SHOWING THE NUMBER OF NORMAL AND DEFECTIVE SEEDS PRODUCED BY THE PARENT PLANTS AND THE BEHAVIOR OF THEIR PROGENY.

Pedigree number of parent ear	Number of seeds		Number of progeny plants		Number of seeds of segregating progeny ears	
	Normal	Defective	Non-segregating	Segregating	Normal	Defective
40–12	185	35	4	2	242	47
40–13	187	64	3	4	567	120
40–17	117	30	4	4	429	147
105– 9	250	73	2	7	1243	407
105–14	all?	.....	9	1	164	42
105–15	all?	.....	1	2	387	129
110– 8	356	101	2	4	697	170
110–12	329	100	3	5	989	342
110–15	all?	.....	5	3	731	138
110–17	142	44	2	2	475	171
110–18	153	71	2	4	510	138
112– 4	all?	.....	5	1	421	146
112– 6	all?	.....	4	1	288	90
Found	1719	518	46	40	7143	2087
Expected	1678	559	29	57	6922	2308
Deviation	+41	−41	+17	−17	+221	−221
Probable error	±13.8		±2.7		±28.1	

are shown, and it can be seen that the same grade of defectiveness in the parents is reproduced in the offspring. Whether this is due to other factors in the plant determining the degree of development of whether there exists an allelomorphic series remains to be worked out.

The character, defective seeds, is a useful one in studies of linkage relations in corn, as it is a seed character and easily classified in most cases. It is also of interest because it is an illustration of defective germ-plasm, which is widely distributed in a cross-fertilized organism and has vital importance in life processes.



ORIGINAL LOT OF SELF-FERTILIZED EARS

Original ears of the variety number 110 self-fertilized for the first time. Nos. 8, 12, 15, 17 and 18 are segregating for the defective seeds. "Specimen No. 12 shows partially defective seeds, while in the one numbered 17 the recessive seeds are completely aborted. . . . In Fig. 9 some of the progeny ears of these two plants are shown, and it can be seen that the same grade of defectiveness in the parents is reproduced in the offspring." (Fig. 15.)

THE FRANK N. MEYER MEMORIAL MEDAL

Designed by Theodore Spicer-Simon, and awarded to Barbour Lathrop as a recognition of his services in the work of introducing foreign plants of economic value into America. A white-barked pine cone and a fruiting branch of the Chinese jujube form the theme on one face of the medal and the First Plant Introduction Expedition that on the other. See the text for translation of the Chinese poem (618 A. D.) and details of the Theban Queen's expedition (1570 B. C.). (Fig. 16.)

FOREIGN PLANT INTRODUCTION MEDAL[1]

Memorial to the late Frank N. Meyer presented to Mr. Barbour Lathrop "for distinguished service in the field of Foreign Plant Introduction"

DAVID FAIRCHILD

President of the American Genetic Association

FRANK N. MEYER, Agricultural Explorer of the Office of Foreign Seed and Plant Introduction, who lost his life in the waters of the Yangtze River, left a bequest of a thousand dollars which was to be used by the staff of that office to defray the expenses of an outing or to be equally divided among them. This was Mr. Meyer's touching tribute to the organization with which he was connected for thirteen years as its agricultural explorer in China, Turkestan and other parts of Asia.

Rather than use the fund thus left by Mr. Meyer for the purpose which he designated in his will, the individuals of the Office preferred to put the bequest into a permanent tribute to his memory in the shape of a medal which should be awarded for distinctive service in the field of foreign plant introduction. This has been done, and the awarding of it one or more times a year it is hoped will not only do honor to those who deserve recognition for their services in this important field of research, but will arouse a wider and keener interest in what is surely one of the most important fields now open for young scientific men—that of the introduction into this country of new food and otherwise useful plants.

The medal, designed by the well known sculptor, Theodore Spicer-Simson, who designed the service medal given to Herbert Hoover by the National Academy of Sciences, has on one side of it a facsimile of the bas-relief which Queen Hatshepsut of the 18th Dynasty (1570 B. C.) had executed upon the wall of her palace at Thebes, to commemorate the first introduction of a foreign plant—the incense tree from the land of Punt. This is the first recorded monument we have to the work of Foreign Plant Introduction. On the reverse side of the medal is the name of Frank N. Meyer, for thirteen years Agricultural Explorer of the Office of Foreign Seed and Plant Introduction through whose bequest the medal is made possible. The Chinese inscription is from a poem by Chi K'ang, a poet of the Tang Dynasty, 618 A. D., which, freely translated, carries the thought that, "In the glorious luxuriance of the hundred plants he takes delight." To the right of this inscription is a fruiting branch of the Chinese tsao or jujube (*Ziziphus jujuba*), the cultivated forms of which constitute one of Mr. Meyer's contributions to the economic horticulture of America;

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[1] The first of the Frank N. Meyer memorial medals for distinctive work in the field of plant introduction, which the associates of Mr. Meyer have had struck in his memory, was presented in the presence of the staff of the Office of Foreign Seed and Plant Introduction and invited guests to Mr. Barbour Lathrop of San Francisco on the 3rd day of May, 1920, in the Homer Building, Washington, D. C.

The associates of Mr. Meyer selected the American Genetic Association as the organization through which this memorial medal shall henceforth be awarded. The address of presentation by the President of the Association is printed in full as it gives the details regarding the meda and a brief account of the plant hunting expeditions of Mr. Lathrop whose work has contributed largely to the supply of plant species with which the plant breeders of America are now working in the production of superior forms of food and ornamental or other useful plants.—EDITOR.

on the left the white barked pine (*Pinus bungeana*), of which Mr. Meyer sent to America thousands of seeds which are now growing in many places in this country, and which in the centuries to come will add to our American landscapes one of the most picturesque of all evergreen trees.

AMERICAN GENETIC ASSOCIATION SELECTED AS TRUSTEE

Since there were certain objections to the awarding by a government office of medals of this character, the associates of Mr. Meyer have selected as their representative in the awarding of this medal the council of the American Genetic Association, an organization having in it as large a proportion of those interested in plant introduction as any organization in America.

In presenting this medal, therefore, I am acting as the representative of the American Genetic Association in the fulfillment of the trust imposed upon it by the associates of Mr. Meyer.

In this capacity I have the honor to announce this afternoon that there will be awarded this year three Frank N. Meyer medals, the first of which it gives me peculiar pleasure to present to my old friend, Mr. Barbour Lathrop, of San Francisco, who has come to be known in the Office of Foreign Seed and Plant Introduction as its "patron saint." I shall have to go back almost a quarter of a century in order to give you a clear idea of Mr. Lathrop's activities in the field of plant introduction which entitle him to receive this distinguished service medal.

BEGINNING OF FOREIGN PLANT INTRODUCTION AS A POLICY

On a small steamer off the coast of Malacca, as the ship's bell struck in the new year of 1897, Mr. Lathrop and I finished a conversation which started us both into the field of plant introduction. Mr. Lathrop's many years of almost continuous travel in foreign countries had impressed upon his mind the significant fact that every country has its own particular foods and that these have their own particular excellence. He saw that a scientific system of plant introduction would be of the greatest benefit to his country. Sitting there in the cabin of the steamer, he outlined his plans to me and convinced me that instead of continuing the researches which through his generosity, I was then occupied with on the fungus gardens of the termites, I should study the food and other useful plants of the countries he had planned to take me through as his guest. Through the following months which we spent in Siam, Australia and the South Sea Islands, the discussions on plant introduction continued, and when we reached Hawaii he investigated the possibilities of the establishment of a garden of plant introduction there but found them unsatisfactory.

Arriving in San Francisco, we parted, and I came on to Washington, where, with the constructive advice and assistance of my old friends Messrs. Swingle, True and Fernow and the willing cooperation of the then Secretary of Agriculture, Hon. James Wilson, whose convictions on the subject were as firm as were those of Mr. Lathrop, the first item was inserted in the appropriation bill which started the work of government plant introduction as a recognized policy.

STUDYING PLANTS IN THEIR OWN HABITAT NECESSARY

After a year of organization work, into the midst of which had been dropped the responsibility for the care of the Hansen collections in Russia, Mr. Lathrop again appeared upon the scene, and with logical arguments spread out over many nights, convinced me that I was no more fit to conduct a Section of Seed and Plant Introduction than a man who had never seen a chicken was fitted to run a chicken coop. His argument was that a world plant collecting service required in it the presence of some one who had seen the whole world, and he offered to take me over its surface in a rapid trip of reconnaissance. While his plan was convincing to me, it failed to convince Mr. Wilson, and it was with reluctance

that he let me go, and it was not until years later that he admitted in a complimentary letter to me that the plans had finally worked out well and that he was satisfied.

Leaving the office in charge of my friend Mr. O. F. Cook, who later was followed by Messrs. Jared Smith and A. J. Pieters, whose conduct of the office during trying times deserves the highest praise, we went through the West Indies, picking up an impression of the great value of the West Indian yam, the chayote, and the dasheen, all three of which are now promising cultures in this country. In Panama we picked up the Calamondine, established in Florida as a beautiful ornamental and one of the best stocks for the orange. From Chile we sent a thousand seeds of a hardy avocado, trees from which seed I had the pleasure of seeing in California last October.

SEARCHING THE WORLD FOR PLANTS OF ECONOMIC WORTH

We crossed the Andes into the Argentine and sent from the Chaco a spineless cactus which later was exploited by Luther Burbank; also seeds of the Maté or Paraguayan tea, which has since become established in South Florida.

Crossing to England, I first made the acquaintance, through Mr. Lathrop's friends, of the Windsor Broad bean—rival of our Lima bean, though not so well suited to our climate. We wandered through Europe to Egypt, stopping in Austria to get acquainted with the Hanna barley and to secure a new and valuable variety of horseradish.

In the Nile Delta the remarkable character of the Egyptian clover or Berseem attracted our attention, and our studies led to a second trip there later, and to a bulletin, which has been translated into Italian and has helped in the introduction of this plant into Tripoli and Tunis but not into America because of the lack of a climate sufficiently like that of Egypt to make it possible.

I can see Mr. Lathrop in my mind's eye today as we argued whether to send in a few seeds or a hundred pounds of seed of the valuable Egyptian cotton varieties. Mr. Lathrop prevailed, and we sent 100 pounds, out of which, through years of careful breeding and selection and wonderful team work, Messrs. Kearney, Cook, Swingle and Scofield have built up an industry for the farmers of Arizona worth to them $20,000,000 a year.

The Lebbek tree, which in honor of the Empress Eugenie and the opening of the Suez Canal was planted in a five-mile avenue to the great Pyramids. was written up and seeds were imported. It is now a landscape feature in parts of Florida.

Back again to the Dutch East Indies we traveled as far as New Guinea, sending collections of rices from Java, arranging for the sending of mango trees from Ceylon, eucalyptus trees from the Island of Timor—trees which are now sixty feet high and are scattering seeds over South Florida—and gathering information in regard to a host of plants which later were imported into America.

From the spice islands of Amboina and Banda, the coast of New Guinea, the Aru Islands, Ceram, Kisser and Letti, and the great mysterious Island of Celebes only a few things reached home alive, but a knowledge of that gigantic archipelago which stretches as far around the globe as New York is from San Francisco, served well to counterbalance the natural provincialism of my middle western education, which would make it appear that the agriculture of this globe is an agriculture of corn, wheat and hogs, and has made it possible to conduct the Office from a broader standpoint.

Turning back toward Europe, we made a quick run into India, and there saw for the first time the Brahmin cattle and the milch breeds of water buffalos. This glimpse enabled us to write an account which was published by Secretary Wilson, and was of assistance, I am informed, in attracting attention to Mr. Borden's remarkable experiments which led to the importation of the Brahmin stock into Texas and the resulting hybrid race of cattle

which has proven more resistant to drouth there than any other breed. The Philippine Islands are now importing, I am told, the milch breeds of the water buffalo which we discovered were of such value in British India.

Sent by Mr. Lathrop to Sweden and Finland to recuperate from an attack of typhoid picked up in Ceylon, I was able to bring to the attention of the department the remarkable seed-breeding establishment of Svalof and incidentally to establish the Finnish Black oat and the Finnish turnip in Alaska, both of which have, according to Mr. Georgeson, added greatly to the food production of that country.

GREAT WEALTH OF PLANT MATERIAL IN CHINA

We returned to America in 1900, and Mr. Lathrop again disappeared for a year from active service for the cause of plant introduction, returning in the autumn of 1901 with the proposal of an Oriental journey for the department, which was accepted, and which in returns exceeded any of the previous expeditions. It brought to the attention of the Office the great wealth of plant material in China and through the acquaintance made of Dr. Augustine Henry, the veteran plant student of that vast country, led ultimately to the exploration of it by our associate Frank N. Meyer, who spent nine years in its study. Our expedition resulted in the introduction of a collection of the East Indian and Cochin China mangos which are now fruiting as large trees in southern Florida, the first of the Persian Gulf date palms, from a single tree of which in southern California as much as seventy-five dollars' worth of fruit were sold this year by the owner. Mr. Lathrop sent me to the Persian Gulf while he made a trip to the east coast of Sumatra, where he secured a quantity of seed of the Sumatra wrapper tobacco in the face of the opposition of the Dutch planters there. The plants from these seeds entered into the hybrids which have made the Connecticut tobacco famous.

From the rich plant field of Japan was sent in a collection of twenty-nine varieties of the flowering cherries, and those who see the cherries on the Speedway in Washington, or the older collection at my place "In the Woods," or the collection in the Golden Gate Park in San Francisco, must thank Mr. Lathrop for the inspiration and encouragement which this collection gave to the widespread cultivation of these glorious trees in America.

GRASSES AND FRUITS SECURED IN AFRICA

Returning again to America in the summer of 1902, Mr. Lathrop and I started out in the autumn of the same year to make a hurried survey of the Dark Continent and sailed down its east coast, stopping at the German colony of Dar Es Salaam and the British colonies of Natal and the Cape. The Rhodes grass, seeds of which were given us by the manager of the Cecil Rhodes estate near Cape Town and which today has become an important hay crop in Florida, Texas and California, and the Carissa, finest of all evergreen hedge plants, which has now become an established thing in south Florida, were secured that year. The Spek-boom, a forage plant upon which the elephants feed, a remarkable small fruited pineapple from Natal, the Limoncella apple of Naples, the Kaffir orange and Kaffir plum of Natal and Cape Town and the Lathrop mango from the Island of Chiloane off the coast of Beira, have all become established in America as the result of this last expedition of Mr. Lathrop's, which ended in the summer of 1903.

Although since then Mr. Lathrop has conducted no long expeditions, his interest in the work of plant introduction has continued. During his travels he has sent us many valuable things, including a most complete account, with photographs, of the soy-bean products of Japan, and during his last trip to that country he sent us what is known there as the most popular vegetable of the Japanese people—the mitsuba—a plant which, although common in our own woods, has never been domesticated, so to speak, by Americans, although in Japan it is grown as extensively as celery is with us.

But of all the things about which Mr. Lathrop has been enthusiastic there is nothing to which he has devoted so much thought as to the subject of the introduction of the Japanese timber and edible bamboos—nothing about which he is more convinced than of its great future importance to America. A collection of eighteen selected varieties and a bulletin on bamboo culture resulted from the expedition in 1902. Later Mr. Lathrop has added a kit of Japanese tools, a collection of baskets and valuable Japanese books on bamboo culture. During the past year he has crowned his work by the gift of a bamboo grove. This gift comprises 46 acres of land near Savannah, Ga., on which is three-quarters of an acre of magnificent bamboo 50 to 60 feet tall, planted years ago by Mrs. H. J. Miller, with plants introduced by Andrias Maynelo, of Savannah. This grove is to constitute the center for the propagation and study of this most important crop for the southern states.

MR. LATHROP'S VALUABLE SERVICES

This is a meager account of the volunteer services which Mr. Lathrop has given for a quarter of a century at his own expense. The valuable advice and the moral support which he gave when they were needed the most and the assistance which he has given to the establishment of so many valuable new industries in our country merit a recognition which his own modesty has made it heretofore impossible to give him, and it is therefore with peculiar pleasure that I who owe so much to him personally as well as officially, present to him in the form of the Frank N. Meyer medal the recognition which I know all of us of the Bureau of Plant Industry who are associated with the work of introducing new plants feel he so justly deserves.

Mr. Lathrop, I present to you the first Meyer memorial medal.

WITH COMMISSIONER CAPERON IN JAPAN

Mr. Lathrop's remarks, upon receiving the medal, carried the audience back half a century to the early days in Japan, when, as a young man visiting there, he met the former United States Commissioner of Agriculture, Mr. Caperon, who had been invited by the Japanese to come over and assist in the organization of Japanese agriculture.

The speech was extemporaneous and it was not Mr. Lathrop's wish that it be published.

LETTER OF PRESENTATION

MAY 3, 1920.

BARBOUR LATHROP, ESQ.,
Bohemian Club,
San Francisco, Cal.

SIR:

The Council of the American Genetic Association has been designated by the members of the force of the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry of the United States Department of Agriculture as the agency through which shall be presented the Frank N. Meyer medal for distinctive service in the field of foreign plant introduction.

Your broad, constructive interest in the subject of plant introduction in the days of its inception in this country; your various expeditions to South America, South Africa, the Dutch East Indies, Japan, China, the Persian Gulf region, Australia, Siam, the South Sea Islands, and the principal countries of Europe and the Mediterranean region in search of new and valuable plants, which not only put the office in touch with the plant collectors of the world, but which assisted most materially in the ultimate establishment in America of the Persian Gulf dates, the Egyptian cotton, the Rhodes grass, the East Indian mangos, the Oriental timber bamboos, the Japanese vegetables Udo and Mitsuba, and many other varieties of plants; your recent gift to the government of an important field station—the Savannah Bamboo Grove—entitle you, in the opinion of the council, to be the first recipient of the Frank N. Meyer medal.

It is with pleasure, therefore, that the council unanimously awards you this medal.

COTTON A COMMUNITY CROP

One-Variety Communities Must be Recognized as the Basis of Production, in Order to Preserve and Utilize Superior Varieties of Cotton

O. F. Cook

Bureau of Plant Industry, U. S. Department of Agriculture

ORGANIZATION may be desirable with any crop, but cotton has a special community feature, the product of many farms going to the same gin. The cotton industry should have been placed on a community basis when public gins supplanted the former system of private or plantation gins, but methods changed gradually and consequences were not considered. Ginning is done with less labor by the modern high-power equipment, but the public gin system has made it very difficult to keep seed pure, or to have superior varieties in general cultivation.

CONSEQUENCES OF THE PUBLIC GIN SYSTEM

Improvement of varieties was more feasible under the old system of private gins because the careful planter could maintain uniform strains of cotton, by selecting the best individual plants, isolating their progenies, keeping the seed separate, and furnishing pure seed to stock other plantations, as the custom was. Present-day farmers very seldom practice individual plant selection, or maintain stocks of pure seed. Different kinds of cotton are grown in the same communities, the seed is mixed at the public gins, crossing takes place in the fields, and degeneration ensues.

According to the general testimony of the cotton trade there has been a serious deterioration in the quality of the American cotton crop in recent decades, which can be understood when account is taken of the effects of mixing and crossing different varieties, and the general use of ordinary "gin-run" seed for planting. The system of plantation gins survived longer in the Sea Island districts of the Southeastern States and the lower Mississippi Valley, so that the long-staple branch of the industry remained on a somewhat better footing until recent years. But with the boll-weevil invasion the dominance of short staple varieties and of the public gin system became complete.

Though it would be considered foolish for a large grower having a private gin to plant several varieties and allow them to become mixed, this is essentially the procedure that is followed by members of cotton-growing communities. It is true that communities seldom own gins, but gins are supported by communities, and ginners as well as farmers would profit through improvement in yield, quality and market value of the crop. Better ginning could be done, and with less difficulty, if only one variety were handled, instead of many kinds.

DETERIORATION OF VARIETIES THROUGH CROSSING

The idea formerly entertained, that cotton is not cross-pollinated, or that crossing is very infrequent and not of practical importance in relation to seed-supplies, has proved to be erroneous. Cotton pollen is not blown by the wind, because the grains are sticky and adherent, but is carried regularly by bees or other insects that visit the flowers, so that varieties growing in neighboring fields are cross-pollinated, in addition to the general crossing that takes place in fields where mixed seed is planted. No matter how good the original varieties may have been, a mixed stock becomes, in a few generations, thoroughly miscellaneous and mongrelized, with many abnormal and infertile plants, very inferior to the parental types.

The degeneration that results from crossing no doubt is the basis of the

popular idea that cotton varieties "run out" in a few years, and that "fresh seed" must be brought in from other districts. But the fact is that locally selected seed of good varieties has proved better than imported seed, when careful comparisons have been made. Moreover, some of the best known varieties have been grown continuously in the same districts for many years, with no indication of "running out," as long as isolation and selection are maintained.

A system like ours, that mixes different varieties together and uses inferior, mongrel seed as the basis of production, no doubt would be considered very backward if discovered in a foreign country. Chinese farmers might be excused on the ground of having no select varieties to plant, whereas American farmers, although they have had superior varieties developed, have not learned how to maintain and utilize pure stocks of seed. In this respect our system must be considered defective and wasteful, not only to the farmer and the manufacturer, but to all who use cotton for any purpose that requires strong or durable fabrics.

EXTENT OF PURE SEED REQUIREMENTS

Full utilization of superior varieties is possible only in one-variety communities, since it is only in such communities that select, uniform stocks can be maintained and increased. The varieties are not fully utilized unless they serve as the basis of crop production over large areas, and for many years. Utilization does not begin until a variety is represented by enough pure seed to plant a field of cotton, and the requirement of pure seed is still the same when the culture of the variety extends over millions of acres. It is not sufficient that an improved variety be adopted by many individual farmers scattered in mixed communities, because this does not provide an adequate and continued supply of pure seed.

There is no prospect of centralizing the production of cotton seed in a few communities or districts for supplying the entire industry. A vast quantity of seed, more than 500,000 tons, is needed for planting the American cotton crop, whereas only about 30,000 tons are handled by seed-dealers. On account of the relatively large size of the seeds, the limited number produced on a plant, the need of heavy seeding, and the holding of reserves for replanting, about ten per cent of the entire crop must be of planting quality to afford a general provision of good seed. The cost of transporting the entire volume of seed would be enormous, in addition to the danger to the whole industry through distributing insect pests or plant diseases, or through failures of crops in seed-supply districts.

THE SOCIAL FACTOR IN UTILIZATION OF VARIETIES

If the utilization of varieties depended upon finding a new chemical to treat the seed or to fertilize the soil, or upon devising a new machine for planting, cultivating or harvesting the crop, the problem would appear normal, and a solution could be sought along the usual technical lines, but social factors enter the reckoning when it is understood that *superior varieties of cotton can be utilized only as they are preserved in one-variety communities*. Except through community action there seems to be no approach to a general application of the science of heredity or the art of plant-breeding in the improvement of the cotton industry.

That pure seed problems should be considered by sociologists is as little to be expected as that plant breeders should study community organization, but a common ground is reached when the practical needs are recognized. Breeders should value community cooperation, while sociologists and economists, as well as teachers and agricultural leaders generally, should take more account of the biological factors that determine the improvement or degeneration of varieties. To devise effective methods of organizing and conducting the activities of one-variety communities, in growing, handling and marketing the crop, and in maintaining the purity and uniformity of the basic stocks, are problems of as much practical importance as the original dis-

covery or breeding of the varieties, and equally worthy of careful, scientific study.

The problems of cooperation are the field of research that needs most to be cultivated at the present time, for the general welfare of the cotton industry. The technical problems, the breeding of superior varieties, and the spinning and weaving of cotton by machinery, are much farther advanced than the general commercial problems of handling, transporting and distributing, which react directly upon production. On account of the present scarcity and acute demand for good fiber, the manufacturing and commercial interests are recognizing the need of research, but without understanding that improved systems of buying and handling the crop are as necessary as improved varieties. Not only facts regarding varieties and textile qualities of different kinds of fiber, need to be investigated, but the whole field of activities that lies between the breeding of varieties and the manufacturing processes.

ENORMOUS WASTE OF PRESENT SYSTEM

The damage to the industry that results every year from the lack of good seed and the resulting failure to utilize fully the resources of production must be estimated in the hundreds of millions of dollars. Replacement of our present inferior, mixed stocks by superior, uniform varieties would give a direct gain of at least ten per cent in quality, and as much more in yield, while another ten per cent might be expected from the cultural improvements that become possible in one-variety communities. Advantages from community handling and marketing of a standardized product would not be less important than the other items, and pure seed can be sold above the oil-mill prices. In returns to the farmer, our present unorganized production may have only a fifty per cent efficiency as compared with what may be found possible in well organized one-variety communities. The general waste of labor and resources of production in the eastern cotton belt contrasts painfully with the one-variety communities of the Salt River Valley of Arizona where the Pima variety of Egyptian cotton is grown exclusively, and the advantages of community organization are beginning to be realized.

ONE-VARIETY COMMUNITIES MORE PROGRESSIVE

Cultural problems are simplified in one-variety communities. Effects of different conditions of soils, seasons, and cultural methods are learned, instead of being confused with differences in the characters of the varieties. The most rapid progress in cotton culture is now being made in the Salt River Valley of Arizona, where only the Pima variety is grown. Cotton problems are discussed with interest and profit at farmers' meetings because everybody has had experience with the same variety of cotton. Such progress is not possible in communities where different kinds of cotton are planted and farmers ascribe their success or failure to the seed.

With adequate understanding of the behavior of one variety, methods are adjusted more closely to differences of soil, season and time of planting, and labor is applied to the best advantage in farm operations, preparing the land, planting the seed, thinning and spacing of the plants in the rows, cultivating, irrigating, harvesting and handling the crop. In weevil-infested regions it is especially important that all the farmers of a community grow the same variety, plant as nearly as possible at the same time, handle the crop together, and clear the fields early in the fall. One-variety communities develop skill, while mixed communities suffer from backward cultural methods as well as from deterioration of varieties.

MARKETING A STANDARDIZED PRODUCT

The final advantage of one-variety communities is in marketing the crop. In an unorganized community the farmer who raises better cotton than his neighbors usually is forced to sell it at the same price to the local buyer. The manufacturer pays more for the high-quality fiber, but the difference is absorbed by the buying trade, instead

of being shared with the farmer. The more valuable bales contribute to the profit of buying and sorting over the miscellaneous "hog-round lots" accumulated by local buyers, many of whom do not know how to "class" the cotton.

Failure to give the farmer practical encouragement in his effort to improve the crop is a serious defect of the present commercial system, but organized communities have a standardized product, better than any of the "even-running lots" that can be made by sorting and matching the inferior fiber of mixed communities so that the commercial problems are simplified. Even in advance of formal organization of communities, a distinct advantage may be shown as the one-variety condition is approached. The general popularity of the big-boll type of cotton in Texas has kept the crop more uniform and given that State an appreciable market advantage in comparison with other parts of the cotton belt. Premiums of $10 to $20 per bale, are being paid in Texas and Oklahoma communities because so many of the farmers grow the Lone Star or Acala varieties that buyers compete for the superior fiber. Active campaigns for commuhity standardization and marketing are in progress in Texas, Oklahoma and North Carolina.[1]

COMMUNITY CHOICE OF ONE VARIETY

No doubt it will be difficult and sometimes impossible to get farmers to agree upon one variety as the best for their community, though too much may be made of this obstacle. Even a poor variety will give better results with community handling than good varieties mixed together. An organized community can change promptly to a superior variety when a definite advantage can be shown. The Pima variety was substituted for the Yuma in the Salt River Valley in one season, after a sufficient stock of seed had been raised. Choice of varieties also is limited at present by the fact that stocks of pure seed are obtainable for only a few kinds. The first one-variety communities in each district will profit especially by selling seed to other communities. Pure seed sells as readily in carload lots as in bushels or tons. Community organization in the Salt River Valley has made possible a rapid extension of Pima cotton because a larger supply of pure seed is available than with any other variety.

EGYPTIAN COTTON COMMUNITIES IN ARIZONA.

It is appreciated in Arizona that the Pima cotton crop of the Salt River Valley communities in 1919 returned about $20,000,000 or nearly twice the cost of the Salt River reclamation project, including the Roosevelt dam, electric power-plants, and irrigation canals. The value of land suited to cotton has doubled or trebled in the last few years, some of it selling at $500 per acre. With reduced production in Egypt and loss of the Sea Island crop through the boll-weevil, the automobile tire industry becomes acutely dependent upon the Pima cotton raised by the Southwestern communities. In the spring of 1920 manufacturers are offering to guarantee a minimum price of 60 cents per pound, or to make contracts at 80 cents a pound, so that a very rapid extension of Pima cotton may be expected, not only in the Salt River Valley, but in the Yuma, Imperial, Coachella and San Joaquin Valley.[2]

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[1] Winters, R. Y., 1919, Community Cotton Improvement in North Carolina, *Journal of the American Society of Agronomy*, 2:121.

[2] See U. S. Dept. Agric. Bul. 533, "Extension of Cotton Production in California," and Bul. 332, "Community Production of Egyptian Cotton in the United States." The community plan in relation to cotton production was outlined in the Yearbook of the U. S. Dept. of Agric. for 1911, pages 397–410, under the title "Cotton Improvement on a Community Basis." Other papers that discuss community features are U. S. Dept. Agric. Bul. 60, "Relation of Cotton Buying to Cotton Growing," U. S. Dept. Agric. Bul. 288, "Custom Ginning as a Factor in Cotton Seed Deterioration," U. S. Dept. Agric. Bul. 324, "Community Production of Durango Cotton in the Imperial Valley," U. S Dept. Agric. Bul. 742, "Production of American Egyptian Cotton," and Bureau of Plant Industry Circulars "Cotton Selection on the Farm by the Characters of the Stalks, Leaves and Bolls" and "Tests of Pima Egyptian Cotton in the Salt River Valley, Arizona."

FRUIT CLUSTER OF THE CUMBERLAND BLACK RASPBERRY

This is a variety belonging to the species *Rubus occidentalis*. The black raspberries under cultivation are natives of North and South America though other species occur in Asia. (P 922.) (Fig. 17.)

ARE OUR RASPBERRIES DERIVED FROM AMERICAN OR EUROPEAN SPECIES?

GEO. M. DARROW
Bureau of Plant Industry, U. S. Department of Agriculture

IT HAS been the common supposition of pomologists that most of our cultivated red raspberries are derived from American species. Varieties from the European species have been considered very susceptible to winter injury while those from the American species have been considered very hardy. Because varieties of red raspberries commonly grown in this country have been moderately hardy they were, therefore, thought to be derived from the American species.

A brief review of the points of difference between the two species of red raspberries which are the parents of our cultivated varieties will show how erroneous this view is.

Rydberg[1] gives the following distinctions between the European and American species:

EUROPEAN SPECIES	AMERICAN SPECIES
Rubus idaeus	*Rubus strigosus*
(1) Plant not at all glandular—hispid	Plant glandular—hispid, especially in the inflorescence.
(2) Stems finely tomentose when young	Stems not tomentose.
(3) Peduncles and sepals tomentose	Peduncles not tomentose, sepals slightly tomentose.
(4) Fruit red	Fruit light-red.
(5) Fruit thimble shaped	Fruit hemispherical.

Card[2] states that *Rubus idaeus* "is stouter and less free in its habit of growth, the leaves are a little whiter beneath, thicker, and generally somewhat wrinkled and the canes are light colored, bearing purple prickles in some varieties. The prickles on the finer parts are firmer, recurved, and less numerous." He also states *R. idaeus* bears more or less throughout the summer and that it is susceptible to winter injury.

Foche[3] makes but one species of both, classing *R. strigosus* as a variety of *R. idaeus*. His distinctions between the two, however, are similar to those of Rydberg, but he emphasizes the fact that while the upper part of the mature plants of *R. strigosus* is densely, rarely sparsely bristly, the upper part of *R. idaeus* is without bristles.

An examination of *Rubus idaeus* grown in this country under garden conditions show that these distinctions are apparently correct. As Rydberg states, the plants are not glandular-hispid, the stems, peduncles, and sepals are tomentose, the fruit is dark red and thimble shaped. As Card states, the canes are stouter, and less free in habit of growth. The prickles are firm, recurved, and less numerous than the bristles of *R. strigosus*. Some of the plants bear in the autumn, though it may be that in the more humid climate of northern Europe they would bear still more in autumn. They are more susceptible also to winter injury than *R. strigosus*. As Focke states, no bristles appear on the upper part of the mature plants of *R. idaeus*.

Examinations of the cultivated varieties of raspberries known to have been introduced from Europe confirm this. (See Fig. 20.) Their fruit is of

[1] *North America Flora*, Vol. 22, Part 5.
[2] F. W. Card, "Bush Fruits," p. 167.
[3] "Species Ruborum," W. C. Focke, p 209.

TABLE I.—*Horticultural Varieties of Rubus Strigosus*

	Variety	Origin	Hairs on peduncles	Tomentum	Leaves
1	Crystal White	New York	Very glandular		
2	Miller	Delaware	Very glandular	None	Medium thick.
3	Ohta	So. Dakota	Very glandular	None	Thin.
*4	Perfection	New York	Very glandular	Slight	Thin.
5	Rancocas	New Jersey	Very glandular	None	Medium thick.
6	Royal Church	Ohio	Very glandular	Slight	
7	Scarlet Gem	Kansas	Very glandular	None	
8	Superb	New Jersey	Very glandular	None	
9	Thwack	New York	Very glandular	None	
10	Turner	Illinois	Very glandular	None	Thin.

TABLE II.—*Horticultural Varieties of Rubus Strigosus Which May Have a Trace of Rubus Occidentalis in Their Parentage*

	Variety	Origin	Hairs on peduncles	Tomentum	Prickles
1	Early Prolific	Kansas	Glandular	None	Slightly recurved.
2	Eaton (Idaho)	Indiana	Glandular	None	Slightly recurved.
*3	King		Glandular	None	Recurved.
*4	Minnesota No. 4.	Minnesota	Glandular	Slight	Recurved (King × Loudon).
5	Minnetonka	Minnesota	Glandular	None	Recurved.
*6	Ranere(St.Regis)	New Jersey	Glandular	None	Recurved.
*7	Sunbeam	South Dakota	Glandular	None	Recurved(Wild red × Shaffer).

a crimson color and not at all the light red of our common wild red raspberry. These varieties have been uniformly susceptible to winter injury. Two varieties only of all those known to have been introduced from Europe are raised to any extent—the Antwerp and the Superlative—both of which are grown in the mild climate of the Pacific Coast while only one other variety of *R. idaeus*, the Surprise of southern California, is raised commercially.

When our other red raspberry varieties are examined they show marked differences in regard to the characters distinguishing the two species. For example, the King is very glandular-hispid especially on the peduncles and sepals; the stems and peduncles are slightly or not at all tomentose; the sepals moderately so; and the fruit is bright red and hemispherical. On the other hand, the Cuthbert is rarely glandular-hispid, is somewhat tomentose, and the berry is crimson and thimble shaped.

The King seems to be a garden variety of *Rubus strigosus*. When we examine the Cuthbert critically it does not seem to belong wholly to either species. On two occasions when plants of this variety were found producing autumn fruit, scattered glandular hairs were found on the penduncles and sepals. Otherwise they seem to be lacking. The stems, peduncles and sepals are more tomentose than *R. strigosus* though not as tomentose as *R. idaeus* while the fruit is thimble shaped and turns a dark red like that of the latter species. It seems to be a hybrid between the two species and this determination is supported by the account of its origin given by Roe,[4] "This is a chance seedling, which the late Thomas Cuthbert found in his garden at Riverdale, N. Y. His son has kindly furnished the following facts: "The

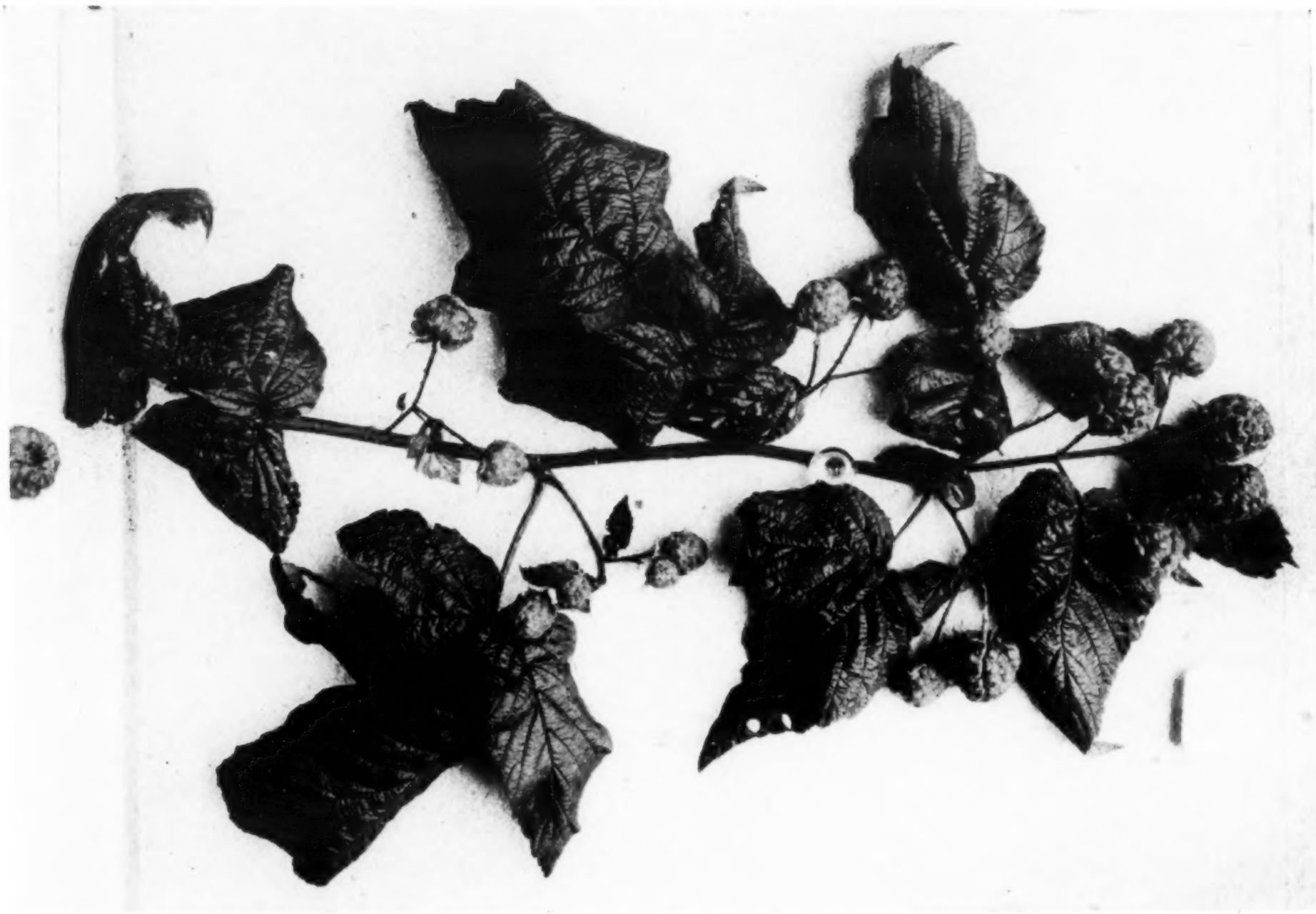
[4] E. P. Roe, "Success with Small Fruits," p. 16

RED RASPBERRY FLOWERS

At the left in the upper row is shown a bud starting to open. In breeding, emasculation should be done just before this stage as the tips of the pistils show through sepals and might receive pollen from other flowers. At the left in the lower row the calyx has opened and the ends of the pistils may be seen in the center. Below at the right the petals are opening but no anthers have opened. Above at the right the petals have dropped and the anthers are shedding pollen. Because the stigmas are receptive long before the anthers open, cross-pollination is very common in the raspberries. (Fig. 18.)

raspberry in question was discovered by my father about eleven years ago (1865) in the garden of our county seat at Riverdale-On-the-Hudson. It is probably a seedling of the Hudson River Antwerp, as it was found growing near the edge of a patch of that variety, but its great vigor of growth and the size and quality of the fruit marked it at once as a new and distinct kind." Roe further states that though the Hudson River Antwerp is distinct from the Antwerp of England, "Mr. Downing says that its origin is known and that it was brought to this country by the late Mr. Briggs of Poughkeepsie, N. Y." It is therefore an European variety.

Thus it seems likely that the Cuthbert is a hybrid between *R. idaeus* and



FRUIT CLUSTER OF THE COLUMBIAN PURPLE RASPBERRY

This variety is supposed to be a hybrid between the Cuthbert red raspberry and the Gregg black raspberry and is therefore a combination of the species *Rubus* (*Idaeus x strigosus*) *x occidentalis*. (Fig. 19.)

R. strigosus. The King is evidently a variety of *R. strigosus*, while Antwerp, Superlative, and Surprise are varieties of *R. idaeus* introduced from Europe.

In the following tables the derivation of the varieties of our red raspberries is given as far as it is possible to do so at this time. The method used to determine their origin has been:

TABLE III.—*Horticultural Varieties of Rubus Idaeus*

	Variety	Origin	Tomentum	Leaves
*1	Antwerp	European	Dense	Thick.
2	Buckeye	Ohio (?)	Dense	Medium to thick, fall fruit.
3	Eastern King	Maine	Dense	
4	Fillbasket	European	Dense	Thick.
5	Franconia	European	Dense	Thick.
6	Hiram	New York	Dense	
7	Ohio Everbearing		Dense	
8	Perfection of Wisconsin	Wisconsin	Dense	
9	Red Merville	European	Dense	Thick.
10	La France (Cobb)	European	Dense	Thick, fall fruit.
11	Segrist	Kansas	None	Thick.
12	Sonchetti	European	Dense	Thick.
*13	Superlative	European	Dense	Thick.
*14	Surprise		Dense	Medium to thick.
15	Syracuse	New York (?)	Dense	Thick.
16	Wisbeck Perfection	European	Dense	Thick.

FRUIT CLUSTER OF THE BUCKEYE RED RASPBERRY

A variety belonging to the European species *Rubus idaeus.* (P 21063) Note that the berries are thimble-shaped, not hemispherical like the berries of the species *Rubus strigosus.* (Fig. 20.)

TABLE IV.—*Horticultural Varieties of Rubus Idaeus × Strigosus.*

	Variety	Origin	Hairs on peduncles	Tomentum	Prickles
1	Crimson Beauty	Kansas	Not glandular	None	Long.
*2	Cuthbert	New York	Very few glands	Fine	Recurved.
*3	Empire	New York	Not glandular	Fine	(Ruby × Coutant)
4	Erskine (Park)	Massachusetts.	Not glandular	Fine	
*5	Golden Queen	New Jersey	Very few glands	Fine	Recurved.
6	Hansell	New Jersey	Very few glands	Slight	Recurved.
*7	Herbert	Canada	No glands	Fine	Recurved.
*8	June	New York	No glands	None	(Loudon × Marlboro).
*9	Marlboro	New York	Very few glands	Fine	(Highland Hardy × Seedling).

TABLE V.—*Horticultural Varieties of Rubus Idaeus × Occidentalis*

	Variety	Origin	Tomentum	Leaves
1	Abundance	Michigan	Fine	Medium to thick.
*2	Royal	Indiana	Fine	Thick.
3	Shaffer	New York	Fine	Thick.

First, an inspection of herbarium material supplemented where possible by observations of the varieties in the field.

Second, a study of the history of the variety.

While this method will be found satisfactory in determining the origin of most varieties, it cannot be accepted as final for some sorts. The more accurate methods of the plant breeder must be used to settle the origin of doubtful ones. Hybrids between varieties representing both species must be made; doubtful varieties must be selfed, and at least an F_1 generation grown. For example, only the results of breeding work can determine just how the character of glandular hairs is inherited. On most of the varieties classed below as *Rubus idaeus* × *strigosus* hybrids, few or no glandular hairs are present, yet in hybrids between *R. occidentalis* and *R. strigosus* glandular hairs are abundant; also in blackberry hybrids between a species having glandular hairs and one without them, the F_1 plants seem intermediate in this respect. It may be that many varieties are hybrids between *R. idaeus* × *strigosus* crossed back on *R. idaeus* or *R. strigosus*. Such hybrids may show but slight traces of one parent.

It is easy to note from the appearance of fruit stems of typical members of each of the species and hybrids between the species, that the contrast between varieties belonging to the European and the American red raspberry species is very marked.

The prominent commercial varieties have been marked with an asterisk (*) Of these it will be seen that five varieties (including those in Tables 1 and 2) belong to *Rubus strigosus*, three to *Rubus idaeus*, six to *Rubus idaeus* × *strigosus*, one to *Rubus ideaus* × *occidentalis*, one to *Rubus* (*idaeus* × *occidentalis*) × *strigosus* and one to *Rubus* (*idaeus* × *strigosus*) × *occidentalis*. The black raspberries have not been listed, as there seems to be no reason to think that any of them are not horticultural varieties of *Rubus occidentalis*.

Certain questions will at once suggest themselves to breeders and pomologists such as:

1. Do the commercial varieties given in Table 2 actually have *Rubus occidentalis* in their parentage? These varieties are known to be hardier than any commercial raspberries in the other groups except those in Table 1 and perhaps Herbert in the group of varieties derived from *R. Idaeus* × *strigosus*.

2. Should not varieties listed in Table 2 be used in breeding sorts for sections with severe climates?

3. All our purple raspberries seem to have *Rubus Idaeus* as one of the parents. Should not hardy varieties of *Rubus strigosus* be used as one parent in future breeding work and a hardy variety of *Rubus occidentalis*, such as Older, be used as the other parent?

4. Why not try other European varieties in the milder parts of the Pacific Coast States as the varieties now grown there are largely introduced from Europe? The Royal Horticultural Society of England recommended in their "Selected List of Hardy Fruits" the Devon, Wisbech Perfection, Baumforth, Hornet, and for autumn fruiting, Alexandra, and Surprise d' Automne. In addition Abundance, Bountiful, Norwich, Profusion, and Semper Fidelis (liked for jam making) might be tested.

ILLUSTRATING THE STRUCTURE AND MATHEMATICS OF THE HUMAN GERM-PLASM

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AN ABACUS is a very simple piece of apparatus, while the germ-plasm is very complex. Still it is possible by such an apparatus to illustrate the basic geography of the chromosome, and also to demonstrate the elementary mathematical principles involved in the segregation and recombination of genes.

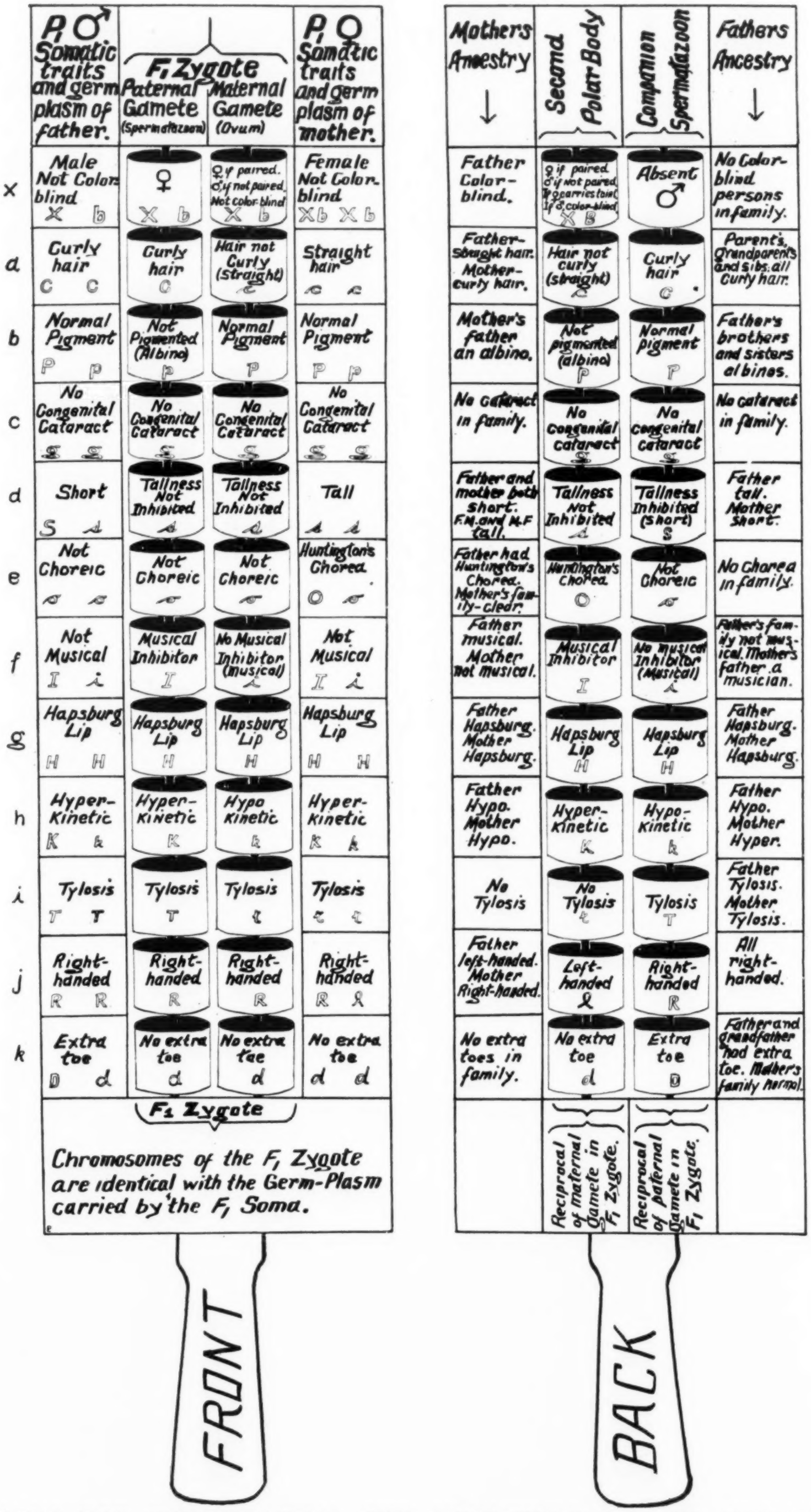
The germ-plasm abacus consists essentially in two rows of spools so arranged that each spool has a definite and homologous companion. There should be as many spools in each string as there are chromosomes in the gametes of the particular species which the apparatus demonstrates. Until more is known in the case of man concerning the shapes and relative lengths of the individual chromosomes, it will not serve any useful purpose to differentiate spool-shapes in this simple apparatus. Later it may be possible to make each spool a model in shape and relative size of the particular chromosome which it represents, so that in such case we would have a much more perfect mechanical model of the human germ-plasm.

The machine here pictured is built of one-half inch strips of wood; the surface of the frame, without the handle, measures 5½ by 18 inches. The spools, or chromosome-models, are made of 1-inch cylinders 1 inch long and mounted on iron rods, so that they may be turned or spun with ease, but each has a catch which meshes into a notch in the rod so that the spool is much more apt to stop at an exact half-turn. This notch-and-catch contrivance is convenient but is not essential, for there are only twenty-four spools to be spun, and after brushing or raking them for the purpose of securing random or chance assortment, the few small adjustments necessary to secure exact alignment require only a few moments.

If there are twelve[1] chromosomes in each human gamete, then there are twelve linkage-groups of traits in man. The breaking-up of these groups would be proportional to the rate of crossing-over in gametogenesis. Whether the genes for the particular twelve traits indicated on this particular abacus lie in separate chromosomes we do not yet know. In future years the instructor in genetics, in manufacturing a germ-plasm abacus, will keep pace with the growth of knowledge of the linear geography of the human gene, just as he will of the shape and relative size of the several chromosomes. But it is useful and perfectly proper to present this tentative arrangement, because the traits indicated have been studied to a considerable extent, and, so far as known, none has been shown to be correlated with another here listed. But by the laws of chance future knowledge will prove several cases in which more than one of this random list lie in the same chromosome, and consequently other chromosomes will be blank so far as the present list is concerned, but by linkage and crossing-over studies the blanks will be readily filled by other genes properly located.

When two or more human genes are demonstrated to lie in the same chromosome, and their relative positions in

[1]Cytologists have not yet agreed on the number of chromosomes in man. According to von Winiwarter (1912) the diploid number is 47 in the male and 48 in the female. According to Wieman (1917) the diploid number is 24 in both sexes, but one pair of which are the idiochromosomes *xy*. (See also Guyer, Montgomery, Jordan, Stevens and Evans.)


P1 ♂ Somatic traits and germ plasm of father.
F1 Zygote
Paternal Gamete (Spermatozoon)
Maternal Gamete (Ovum)
P1 ♀ Somatic traits and germ plasm of mother.
Mothers Ancestry
Second Polar Body
Companion Spermatozoon
Fathers Ancestry
x Male Not Color-blind X b
♀ X b
♀ if paired. ♂ if not paired. Not color-blind X b
Female Not Color-blind Xb Xb
Father Color-blind.
♀ if paired ♂ if not paired ♀ carries taint If ♂ color-blind X b
Absent ♂
No Color-blind persons in family.
a Curly hair C C
Curly hair C
Hair not Curly (Straight) c
Straight hair c c
Father-Straight hair. Mother-curly hair.
Hair not curly (straight) c
Curly hair C
Parent's, Grandparent's and sibs. all Curly hair.
b Normal Pigment P p
Not Pigmented (Albino) p
Normal Pigment P
Normal Pigment P p
Mother's father an albino.
Not pigmented (albino) p
Normal pigment P
Father's brothers and sisters albinos.
c No Congenital Cataract S S
No Congenital Cataract S
No Congenital Cataract S
No Congenital Cataract S S
No cataract in family.
No Congenital Cataract S
No Congenital Cataract S
No cataract in family.
d Short S s
Tallness Not Inhibited s
Tallness Not Inhibited s
Tall s s
Father and mother both short. F.M. and M.F tall.
Tallness Not Inhibited s
Tallness Inhibited (Short) S
Father tall. Mother Short.
e Not Choreic
Not Choreic
Not Choreic
Huntington's Chorea O
Father had Huntington's Chorea. Mother's family-clear.
Huntington's Chorea O
Not Choreic
No Chorea in family.
f Not Musical I i
Musical Inhibitor I
No Musical Inhibitor (musical) i
Not Musical I i
Father musical. Mother not musical.
Musical Inhibitor I
No musical Inhibitor (Musical) i
Father's family not musical. Mother's father a musician.
g Hapsburg Lip H H
Hapsburg Lip H
Hapsburg Lip H
Hapsburg Lip H H
Father Hapsburg. Mother Hapsburg.
Hapsburg Lip H
Hapsburg Lip H
Father Hapsburg. Mother Hapsburg.
h Hyper-Kinetic K k
Hyper-Kinetic K
Hypo Kinetic k
Hyper-Kinetic K k
Father Hypo. Mother Hypo.
Hyper-Kinetic K
Hypo-Kinetic k
Father Hypo. Mother Hyper.
i Tylosis T T
Tylosis T
Tylosis t
Tylosis t t
No Tylosis
No Tylosis t
Tylosis T
Father Tylosis. Mother Tylosis.
j Right-handed R R
Right-handed R
Right-handed R
Right-handed R r
Father left-handed. Mother Right-handed.
Left-handed r
Right-handed R
All right-handed.
k Extra toe D d
No extra toe d
No extra toe d
No extra toe d d
No extra toes in family.
No extra toe d
Extra toe D
Father and grandfather had extra toe. Mother's family normal.
F1 Zygote
Chromosomes of the F1 Zygote are identical with the Germ-Plasm carried by the F1 Soma.
Reciprocal of maternal Gamete in F1 Zygote.
Reciprocal of paternal Gamete in F1 Zygote.
FRONT
BACK

AN ABACUS FOR ILLUSTRATING THE STRUCTURE OF THE HUMAN GERM-PLASM. (Fig. 21.)

the chromosome are known, their symbols may be inscribed in their true linear relationship upon the same spool in the germ-plasm abacus. Their genetic behavior will then be automatically demonstrated in manipulating the machine in the usual manner. With this understanding the tentative list may well stand, but the fact that the given assortment is arbitrary does not destroy its teaching value in demonstrating the proven structure of the germ-plasm, the mechanical principles and mathematical possibilities in the segregation and recombination of traits.

The following paragraphs describe the features of this abacus and their analogies in the human germ-plasm:

1. The curved surface of each spool is divided vertically by black marks into two equal areas, each of which represents one of the two possible chromosomes, either of which the parent manufacturing them may contribute to the F_1 zygote. One of these chromosomes the said parent in turn received from his or her father, and the other from his or her mother.

2. The front face of each chain of spools, in any combination, represents the number and genic composition of the chromosomes characteristic of the gamete contributed to the F_1 zygote by the parent proliferating it. If desired one "chromosome-face" may be labeled ♂ to indicate its paternal origin and the other ♀ to show its maternal origin.

3. The two sets of spools are in parallel and homologous position, as probably is the case with chromosomes just before the formation of the equatorial plate when the gametes fuse to make the fertilized egg or zygote. But still more definitely this parallel and homologous position is exactly analogous to the chromosomal situation during para-synapsis, preceding the first maturation division.

4. All of the potentialities of the two parents in reference to their chromosomal combinations (barring crossing-over and other special phenomena) are here shown mechanically and may be mathematically demonstrated by turning the spools into their several possible combinations.

5. With this apparatus one may give a mechanical demonstration of the three normal genetic types of parents, and the consequent six types of Mendelian matings in reference to a single trait. The student examining the abacus here shown soon finds that, so far as breeding potentialities are concerned, the F_1 male parent (the father) is positively homozygous, that is, duplex in reference to traits C, H, T, and R; the mother in reference to traits X and H. The father is heterozygous, that is, simplex in reference to traits X, P, S, I, K, D; the mother to traits P, O, I, K, R. The father is negatively homozygous, or nulliplex, in reference to traits g and o; the mother to c, g, s, t, and d.

6. Let us next consider the possible types of matings. The gene H for the trait here shown in chromosome g presents an example in Mendelian Case 1 (DD × DD = 100% DD.) Genes X and R here listed in chromosomes x and j. Case 2 (DD × Dr = 50% DD and 50% Dr.) Genes C and T in chromosomes a and i. Case 3 (DD × rr = 100% Dr.) Genes P, I, and K in chromosomes b, f and h. Case 4 (Dr × Dr = 25% DD, 50% Dr and 25% rr.) Genes S, O and D in chromosomes d, e and k. Case 5 (Dr × rr = 50% Dr and 50% rr.) Gene g in chromosome c, Case 6 (rr × rr = 100% rr.)

7. In most bi-sexual species, the cause of sex, so far as it has been traced in the reverse order of ontogeny, is found to lie in a chromosomal difference in the zygote and gamete. Sex-difference for the most part is the principal somatic difference within a species. It is therefore logical to expect a greater difference between the chromosomes of a male-producing and a female-producing zygote than will be found to accompany any other contrasted traits within the same species. In man the male is heterozygous, the female positively homozygous. In the

accompanying apparatus the spools pictured as representing the x-chromosomes are labelled to show the fundamental sex-plan, and other symbols are added representing the presence and absence of the gene for color-blindness, which is known to be a sex-linked trait. When the machine is manipulated, it presents a correct mathematical picture of the sex-ratio and of the distribution of sex-linked traits among the children of the parents described on the margin.

This abacus does not demonstrate all of the phenomena of bi-sexual heredity, but it gives a correct structural and mathematical picture of the basic properties of the human germplasm. The pedagogical value of the machine would be lessened if it were made more complex. Rather than complicating this device, other machines should be contrived for illustrating such special phenomena, for example, as crossing over and non-disjunction.

8. In manipulating the machine, the novice learns that in normal cases in each egg or spermatozoon there is always a maternally or a paternally descended chromosome (one or the other of the two faces of a spool) representing each definite chromosome characteristic of the gametes of the species. Then in reference to the descent-combinations of two chromosomes, for example, a and b, a given parent is capable of producing four kinds of gametes. In general the total number of descent-combinations of chromosomes possible in the gametes of a given individual is equal to 2^n, in which n is the number of chromosomes characteristic of the gamete (that is the haploid number) of the particular species. He learns also that for each single pair of contrasted traits there are four possible definite chromosomal combinations in a zygote organized from the gametes of two given parents. Thus barring crossing-over and other special phenomena, the number of possible chromosomal combinations in the zygote which may result from a particular human mating is 4^{12}. If the formula be generalized, then the number of different chromosome-combinations possible among the full brothers and sisters of any bi-sexual organism, barring crossing-over and other special phenomena, is 4^n, in which n is the number of chromosomes characteristic of the gametes of the species.

9. If, when the machine is set for a given F_1 zygote, the examiner turns it over, he finds on the backs of the spools the genes reciprocal or allelomorphic to those found on their respective fronts. In the case of the paternally descended gamete, the reciprocal is another possible spermatozoon, which by chance was not used in making the F_1 zygote organized as shown by the front of the spools. This reciprocal gamete has all of the genetic possibilities of the male parent other than those which are not contained in the spermatozoon which actually entered the particular F_1 zygote.

10. The case of the reciprocal of the female gamete or ovum is somewhat different, so far as ability to function as an egg is concerned, but in the reciprocal or allelomorphic nature of the chromosomes and genes, the situation is exactly parallel to that found in the case of the male gametes. The cell reciprocal to the ovum is the second polar body,[2] and having the chromatin composition in the nucleus required of a perfect egg, would perhaps so function if its cytoplasmic composition were adequate.

[2]In species in which the first maturation division consists in organizing two dyads of exactly similar composition, the allelomorphs (that is the backs of the spools) of the female gametes shown by this abacus properly represent the second polar bodies. If, however, the first maturation division results in two dyads of dissimilar composition, that is one completely paternal and the other completely maternal in origin, the allelomorph of the ovum as shown on the back of the spools presents a gene-picture of one of the two cells resulting from the division of the first polar body. So far as this particular point is concerned, this machine, because the back is in the appropriate place labelled "Second Polar Body," rather than "Polar Cell," represents faithfully those forms in which the two dyads are exactly alike.

11. Thus every parent, in reference to a single trait, may contribute one or the other of two genes, one of which came down unchanged (barring mutation) from his or her father, the other from his or her mother. Of course, if the blood is pure and these two genes are alike, they cannot be distinguished in their working-out in the F_1 soma. This is the case with trait H in chromosome g, and trait g in chromosome c, but this does not mean that the rules of segregation and recombination have not been just as active throughout as is so easily demonstrated with the highly contrasted genes and characters of mongrels.

12. In order to represent the continuity of the germ-plasm, let the F_1 zygote be thought of as a parent. Whereas the possibilities of the original P_1 individuals of the abacus for a single trait are shown by the two faces of a single spool, now the possibilities of the F_1 individual as a parent are shown by the front faces of the two adjacent spools, which are now held stationary. Those genes whose symbols are indicated on the backs of the spools have been lost to the race in this particular case. Thus not only the principles of segregation, combination and continuity, but also of elimination, are mechanically shown. To every one of the descendants of the F_1 zygote, one or the other of the two chromosomes or genes-radical shown on the front faces of adjacent spools will pass. If two of these abaci are placed side by side, with the spools stationary in one abacus to represent a parental male zygote, and in the other a parental female zygote, the situation may be used to demonstrate the inbreeding of the F_1 generation, but instead of spinning the spools the combinations for the F_2 offspring are made by chance selection of either the right or left (that is, either paternally or maternally descended) face of the front-turned spools in the two abaci. By this process one may trace the chromosomes and their component genes from generation to generation.

The manipulation of this machine gives not the whole story of human heredity, but a clean-cut demonstration of the geography[3] of the bi-sexual germ-plasm and of its normal basic mechanism and mathematics.

Moral Qualities and Eugenics

The Lancet (London, November 8, 1919) says: "Dr. I. M. McCaillie has published certain results obtained by this method (psychological tests) in the American Army, and it is interesting to note that a majority of cases of absence without leave, desertion, confinement to barracks, and reduction in rank occur among men found to be below the average of intelligence, as shown by the tests employed, and the use of psychologists to investigate the mentality of criminals might well have fruitful results."

Any measurements of moral differences among adult human beings are so rare that notice should be taken by psychologists and eugenists of the results obtained by Dr. McCaillie. They confirm the correlation of mental and moral qualities found by Woods in royalty (1903).[4]

There have been some scattering figures obtained by persons who have made studies of school children and particularly of delinquents in state institutions, all of which support the notion of mental and moral correlation.[5]

If morally superior persons are on the average more liberally endowed mentally it means much encouragement for the eugenists in their ideas for the betterment of mankind.

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[3] See (a) "The Physical Basis of Heredity," by T. H. Morgan. (b) "Are Genes Linear or Non-Linear in Arrangement?" by W. E. Castle, Proceedings of the National Academy of Science, November 1919.

[4] The correlation ratio was found to be $r = .34 \pm .04$, "Heredity in Royalty," New York, 1906, p. 259.

[5] See JOURNAL OF HEREDITY, Feb., 1919, pp. 84–86.

A PHYSICAL CENSUS IN ENGLAND AND ITS LESSON

Two-thirds of the Population Not Healthy

THE RESULTS of the physical examinations of drafted men in England for the first eight months of 1918, show that "between January 1 and August 31, 1918, the number of medical examinations conducted by National Service Medical Boards in Great Britain amounted to 2,080,709. Of the two million men examined not more than 36 or 37 per cent were placed in Grade 1—that is, approximately only one in every three has attained the normal standard of health and strength and was capable of enduring physical exertion suitable to his age; the remainder—more than a million and a quarter—did not reach this standard. The suggestion has been made that the low proportion of fit men among those examined during this period was due to the fact that only the leavings of the population were under review. Analysis of the records available, however, shows that this is not the case, and that as a fact the men examined constituted a fair example of the male population between the ages of 18 and 43 and a smaller proportion of the more fit between 43 and 51. We are told further that the experience of the boards medically examining women for national works corresponds broadly to that of the National Service Medical Boards examining men. Such evidence points only too clearly to a deplorably low state of health."

In comment on the above the Editor of the *British Medical Journal* makes the following remarks:

"While it has not yet been possible to work out the details of this great mass of medical examinations, the preliminary results indicate that preventable disease is responsible for the bulk of the physical disabilities, and demonstrate the ravages which industrial life has made upon our real national capital—the health and vigor of the population. Too little food, too long hours of work, too little sleep, too little play, too little fresh air, too little comfort in the home are evidently the chief factors concerned in producing this mass of physical inefficiency with all its concomitant human misery and direct loss to the country. To take effective measures on the broadest lines to remedy this condition of things is a most urgent duty. Although real improvement can hardly be expected for one or two generations, the foundations of a better national physique can be laid at once[1]."

It would seem that this editorial writer in the *British Medical Journal* does not see into the complexity of the problem, or understand modern views on heredity. In so far as these disabilities are the result of a bad environment, an improvement may be rightly expected to accrue, and this change for the better may be looked for at once, not, as the editor supposes, after one or two generations. Does this writer cling to a belief in the inheritance of acquired traits? But is it not conceivably possible that this physical deterioration is *in part* due to an adaptability of mankind to a less brutal system of natural selection than took place among our primitive ancestors? Indiscriminate charity and excessive altruism, to say nothing of the inevitable and commendable features of civilization, have doubtless enabled the congenitally weak to survive. Large portions of the population are not healthy (Grade I in the martial sense), but they are nevertheless healthy in sense of being able to survive and beget offspring. This feature of the problem cannot be either denied or ignored.—F. A W.

[1] Edit., *Brit. Med. Journal*, 1918, 348–9.

A SYSTEM FOR BREEDING CORN OR GREGARIOUS ANIMALS

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DURING the past three years, the writer has attempted to conduct a corn breeding system that should accomplish the three following requirements:

(1) Insure continuous ear-to-row selection for high yield by using ears or remnants from tested rows.

(2) Insure direct cross-pollenation between high yielding strains, thus avoiding the usual ill effects of in-breeding; with the use of a single ear in each quarter of the plot for all sire rows and detasseling all even-numbered rows.

(3) Annual introductions of strains from outside sources, *through the even-numbered detasseled rows of the breeding plot.*

The first of these attempted requirements is based upon the assumption that some sort of selection is bound to be the basis of progress in corn-breeding. The second is intended to recognize the principle that it is usually desirable to secure the crossing of strains that have previously been inbred or at least closely bred. (Hybridization Methods in Corn Breeding. Shull —*American Breeders Magazine*, April-June, 1910.) The third feature namely, the introduction of outside strains, conforms to the idea that "selection is a sieve," or at least it may be. There can hardly be a practical reason why a corn breeder should start with a given number of mother ears, say ninety-six, and assume that all determinants of high yield are included within the number originally selected.

Furthermore, the plan of introducing ears from outside the breeding plot into the even-numbered detasseled rows gives opportunity for testing the yielding power of such introductions before permitting them to mature pollen, and consequently makes it possible to discard them entirely if they are found unworthy, without contaminating the other "blood lines" of the breeding plot. This idea conforms to the earlier suggestion of Williams of Ohio. The plan, or combination of plans employed here is described concretely in the South Dakota Experiment Station Bulletin No. 186.

The writer would suggest that this idea of making introductions into corn breeding plots through the "dam lines" ought to be extended. The chief reason for adhering to the plan of dividing the breeding plot into four squares of twenty-four rows each (adapted from Illinois Experiment Station Bulletin No. 100) is to secure a greater number of relatively short rows and a relatively large number of introductions into these "dam rows," and also to enable one to plant all "sire-rows" in each quarter with a single ear.

It is arbitrary enough to make four quarters of a corn-breeding plot with all odd-numbered rows in each quarter planted from a single high-yielding ear, and with all the twelve even-numbered rows detasseled, with three new introductions among the twelve each year. It works out conveniently.

The essentials of the plan of this corn breeding plot might be adopted by poultry breeders, who have a sufficient number of birds to divide into four pens, each with its quota of hens and one male bird. The rule would be, that all birds in all four pens should be leg-banded and the hens faithfully trap-nested and their egg records kept.

At the beginning of any given sea-

son, the cockerel for pen No. 1 would be selected from the brood of the hen with the highest egg record in pen No. 4. The cockerel for pen 2 would, in like manner be the progeny of the hen with the highest egg record in pen 3. The cockerel for pen 3 would be selected from the progeny of the hen with the highest egg record in pen 1, and the cockerel for pen 4, would be selected from the progeny of the hen with the highest egg record in pen 3.

With such an arrangement, introductions of new blood lines could be made by the addition of one or more hens to each or all of the four pens. Such hens would of course be carefully numbered and their records kept, and in the event they failed to make a worthy record, they themselves and all their progeny could be eliminated from the flock by culling.

It is worth oft repeating that the art of breeding will be most rapidly forwarded on a general basis of rigid selection with statistical records of performance. The device here outlined, for corn, or poultry, may increase interest and intensity of selection; calling especial attention to the possibility of making introductions of new blood lines in a systematic way through the female side.

Another consideration in offering this 4-parted system for breeding corn or gregarious animals consists in its adaptability to cooperation in breeding work. For instance in poultry breeding it may prove impracticable for any given breeder to arrange four pens as suggested in the foregoing. In such a case it may be possible for four poultry breeders each to arrange one pen, and to so cooperate that all may get the benefit of a systematic unit. Such cooperation would inevitably be beneficial to corn, or poultry, or sheep, or what not; it would be a community service along a specific line.

As such it is worth consideration by various community advisers.

RACE AND NATIONALITY, an inquiry into the origin and growth of patriotism, by John Oakesmith, D. Lit., M.A. New York: Frederick A. Stokes Co., 1919. Pp. 300. Price, $4.00.

Dr. Oakesmith begins by wiping up the earth with authors who have held racial differences to be the basis of differences in national feelings. On the whole, he makes a good job of this—but then, he has picked out the extremists, whose work was most vulnerable, for his attack. He concludes that "race, as a constituent element in nationality is a purely subjective emotion," and then builds up his own theory, which explains nationality as "the common interests of a people developed through generations into a characteristic traditional culture." Few reasonable people will object to this definition, and they will find much of interest in the rest of the book, which is largely devoted to illustrating, by the case of England, the development of a feeling of national consciousness. The book is, however, marred throughout by the absolute lack of a biological viewpoint, and by a literary rather than scientific treatment of the facts.—P. P.